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METHODS OF CHEMICAL CONTROL IN CANE SUGAR FACTORIES

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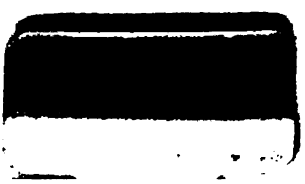

METHODS OF CHEMICAL CONTROL

IN

CANE SUGAR FACTORIES.

METHODS OF CHEMICAL CONTROL

IN

CANE SUGAR FACTORIES.

BY

H. C. PRINSEN GEERLIGS,

Director of the West Java Sugar Experiment Station,

Pekalongan, Java.

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PREFACE.

The matter contained in the first 47 pages of this volume originally appeared in the *International Sugar Journal* (Vol. VI., 1904,) as far as the English version was concerned. It is now, at the desire of the author, reprinted in book form with the addition of numerous tables and plans not hitherto published. These latter will, it is hoped, enhance the interest and value of the whole, and justify the publisher in his production of an English Edition of a valuable Dutch handbook.

June, 1905.

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PART I.

DAILY REPORT.

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ANALYTICAL METHODS.

I. CANE.

1. LABORATORY SAMPLES.

Sampling.—From every cart-load of cane entering the factory, retain two canes and put them in a cool place protected from wind and rain. Early in the morning the canes are counted and one taken out from every ten, in which sample determine:

Fibre.—Take from the sample mentioned above, without picking, as many canes as weigh about 25 kilogrammes, cut them in pieces, weigh and crush them in a small test mill, extracting about 72% juice from 100 parts of cane. Weigh the bagasse resulting from this operation, chop it into coarse pieces, mix thoroughly and crush part of the sample to a fine powder. Extract 20 grammes of this powder in a Soxhlet extraction apparatus with alcohol, dry the extracted fibre, weigh it and calculate the weight on 100 parts of cane. This estimation is to be made once a day.

Example.

	Kilogrammes.
Weight of cane crushed	25
Weight of bagasse	6
Weight of juice extracted	19
Fibre content of the bagasse	43·75%

Then the fibre content of the cane $= \frac{6 \times 43{\cdot}75}{25} = 10{\cdot}5\%$

2. FACTORY SAMPLES.

Sampling.—From every cartload of cane entering the factory, keep apart one or two bundles, and pile up the bundles of each field on

their own special heap, so that every heap contains the canes cut that day from its own field. Once a day these heaps are crushed separately by the factory mill, and the first mill-juice is continually sampled by taking small quantities of the juice from the gutter with a small measure glass and pouring it into a bottle or kerosine oil tin.

In the samples determine degrees Brix, sucrose, and quotient of purity. The available sugar is calculated for 100 parts of juice after the formula: Quotient × sucrose of first mill juice ÷ 100; and for 100 parts of cane after the formula: 0·8 × quotient × sucrose of first mill juice ÷ 100. In such a way no absolutely accurate figures are obtained, but they are mutually comparable. At the end of the grinding season the real production of each field can be found by multiplying the thus obtained approximate figures with the factor representing the proportion between the sugar actually produced over the whole estate, and the sugar calculated from all the fields in the above-mentioned way.

3. FIELD SAMPLES.

Determination of the point of maturity of the cane field.—The cane fields are divided into plots which have been planted and manured at the same time and in the same way. After 10 months of growth take from every plot 40 normally grown cane plants, mark and number them. Every fortnight one cane stalk is cut from each one of the stools and the bundle carried to the laboratory, where the green top-end is removed and the canes are measured, weighed, and crushed in a small test mill, after which the juice is analysed. The analytical data from each analysis of the same plot are entered down so that an increase of sucrose content, or purity, or a falling in them can be detected at once. As soon as the sucrose content or the purity cease to augment, the cane of the plot under review has attained its point

of maturity and should be cut in order to prevent deterioration by too long standing in the field.

The results are put down in the following table, in which the percentage of diseased or worm-eaten canes is also recorded :—

Number or name of the field .....

Date of planting.	Date of analysis.	Number of canes.	Length of the cane.	Weight of the cane.	% attacked by borers.	% attacked by diseases.	Composition of the juice.			% juice extracted.
							Brix.	Sucrose.	Quotient.	
	.	.	.	.	.	.	.	.	.	

Fallen canes are not analysed.

II. BAGASSE.

Sampling.—The bagasse is sampled at the last mill by taking every now and then a small quantity of bagasse and throwing it immediately into a basket, covered with a lid. Once every hour this sample is brought to the laboratory, mixed, chopped rapidly, and of this bagasse we weigh without delay for

Determination of the sucrose.—20 grammes ; these are put in a tared tin cylinder, weighed again and moistened with 300 grammes of water and 3 c.cm. of subacetate of lead, after which the mixture is heated and boiled for ten minutes. In order to promote clearness of the liquid 5 drops of a 10 % solution of carbonate of soda are added, the

mixture is then cooled down to the ordinary temperature, afterwards weighed again and the weight noted; next the liquid is filtered and polarised in a 400 mm. tube.

The sucrose content is read in a table, in the consulting of which we must keep in mind that the fibre content of the bagasse is taken to be 45 % and the weight of both bagasse and liquid to be equal to their volume (*i.e.*, that their specific gravity = 1). The total amount of liquid is therefore not only the difference between the weight of the cylinder + bagasse, and that of the cylinder + bagasse and the water after boiling and cooling, but augmented with the juice already present in the bagasse, viz., 55 % of 20 grammes or 11 grammes.

	Gr.
Tared cylinder	350
20 grammes of bagasse	20
	370

	Gr.
Cylinder + bagasse + water and chemicals after cooling	657
	370
	287

The amount of liquid thus amounts to 287 + 11 = 298 grammes.

Suppose the polariscopic reading be 2·2 then according to the table the sucrose content of the bagasse would be 4·26 %.

Determination of the dry substance.—20 grammes of the chopped bagasse are weighed, transferred to a tared shallow tin dish of 1½ sq. dm. surface and dried for 5 hours at 100° C. or, if the bagasse is dried by steam, at 95° C. to constant weight. When by accident the temperature has risen too high (evidenced by the yellow or brownish tinge of the

dried material) the result of that analysis should not be taken into account when calculating the average dry substance.

Determination of the Fibre.—The fibre content is calculated once a day from the average content of dry substance and sucrose of the bagasse and the quotient of the last mill juice. In this case we suppose the quotient of the juice in the bagasse to be equal to that of the last mill juice, a supposition which does not depart much from the truth.

Example.

Dry substance in bagasse.. .. .. 54·0
Sucrose in bagasse.. .. .. 4·30
Quotient of last mill juice .. .. 73·

then the soluble dry substance of the bagasse=$4{\cdot}3 \times \frac{100}{73} = 5{\cdot}9\%$
and the fibre or insoluble dry substance=54·4—5·9=48·50.

If one wants to determine in a direct way the fibre content of the bagasse a fixed quantity is weighed from every sample and these quantities are collected in a stoppered bottle; once a day the contents are mixed, 10 grammes are extracted with alcohol in a Sexhlet extraction apparatus and the dried fibre is weighed after being perfectly dried.

The determination of sucrose is made every hour, the moisture is determined if possible once every two hours, and the average is calculated from the results of those determinations once every 24 hours.

III. FIRST AND LAST MILL JUICE.

Sampling.—During grinding small quantities of juices are continually taken from the gutters with a 10 c.cm. measure and poured into tins, provided with a funnel of wire gauze; every hour the tins are brought to the laboratory.

Preparation of the Sample.—The juice is well mixed and next filtered through a funnel of very fine metallic gauze into a copper or tin cylinder provided with a discharge pipe about three inches from the bottom, which pipe can be closed with a rubber tube and a cock. The juice is left in the cylinder for half an hour so as to allow the mud to subside and the scum to rise; after that time the clear juice is ready for analysis and may be drawn off by opening the cock.

Determination of degrees Brix.—Plunge a Brix Hydrometer, verified at 17·5° C into the juice, read the temperature and the scale of the hydrometer and correct the latter from the reading of the thermometer. Measure out 100 c.cm. of the juice and pour them into a stoppered bottle in which a quantity of corrosive sublimate has been thrown equivalent to 0·25 grammes for every litre of juice expected.

Once every 12 hours the contents of the bottle, representing the average of the 12 subsequent hourly samples are well shaken and mixed, next the degrees Brix are determined again as a check on the previous determinations in the hourly samples, subtracting from the corrected Brix degrees 0·05 as a correction for the increase in specific gravity occasioned by the addition of the corrosive sublimate; a $\frac{110}{110}$ flask is filled to the lowest mark with the juice, 3 c.cm. of subacetate of lead added; we complete with water to the upper mark, shake, filter, and polarise in the 200 mm. tube. The sucrose content can

be calculated from the polariscopical readings and the uncorrected average Brix by the well-known tables of Schmitz, or after the formula: $S = \frac{\text{pol.} \times 26{\cdot}048 \times 1{\cdot}1}{200 \times \text{sp. gr.}}$

Quotient of Purity.—Divide the sucrose by the degrees Brix and multiply by 100.

IV. MIXED JUICE.

Sampling.—Take from each filled measuring tank an always identical quantity which ought to be so much that one hour's work yields enough for analysis. The preparation of the sample, the determination of Brix, sucrose and quotient are exactly as just described for "first mill juice." It is to be recommended in order to avoid sourness and fermentation in the samples of mixed juice, which remain without a disinfectant, to use two sets of tins and measures, which are well cleaned and dried alternately.

Determination of the glucose or reducing sugar.—Although the determination of the glucose is not strictly necessary for the control, it is advisable to estimate the amount of this constituent in the mixed juice and in the syrup with a view to detect an eventual inversion or sourness of the juice between those stages.

Measure from each sample of mixed juice, prepared for the polariscopical test, 25 c.cm. and pour them into a stoppered bottle; next analyse the contents once every 24 hours. To this end 20 c.cm. of the juice are pipetted in a 100 c.cm. flask, one precipitates the surplus lead with a solution containing 5% of sulphate and 5% of carbonate of soda, fills up with water to the mark, shakes, filters into a burette and the resultant is used for the precipitation of 10 c.cm. of Fehling's test

solution of half strength (so called half normal Fehling's solution). The 10 c.cm. of that half normal solution are pipetted in a Erlemeyer flask, 40 c.cm. of water is added as well as a few drops of strong soda lye and the whole is boiled on a methylated spirit or Bunsen lamp. Run into the hot solution from the prepared juice from the burette a little less than is thought necessary, boil again and keep boiling during one minute, allow the red precipitate to settle and observe the coloration of the clear liquid. If it is still blue, a little more of the juice is to be added, if colourless then the proper point is reached, but if the liquid is yellow the test should be repeated with a smaller quantity of the juice. If the discoloration is only obtained after two or more additions of juice there is danger that a little of the red oxydule has become redissolved again and that therefore the result will be a too low figure for the glucose. In order to avoid this the experiment should be repeated with so much juice that the total precipitation is obtained after (at the most) three additions of juices. When the red precipitate does not settle quickly, add about 10 c.cm. of a solution of gypsum and boil again.

The total disappearance of the blue colour of the supernatant liquid can be obtained by experienced operators by simply looking through it. At any rate it may be controlled by taking out a drop of that liquid with a glass rod and mixing it with a drop of solution of ferrocyanate of potash lying on a porcelain plate and acidulated with acetic acid just before the addition of the drop to be tested. A brown coloration detects the presence of dissolved copper in the liquid and shows that in the next test more of the juice should be used.

Glucose ratio.—Divide 100 × the glucose by the sucrose content.

V. CLARIFIED JUICE AND FILTER PRESS JUICE.

The analysis of these juices is made in the cooled down samples in the same way as described under "Mixed Juice."

VI. FILTER PRESS CAKES.

Sampling.—After the filter press cake is discharged, take samples from them with a sample iron, knead them well in a mortar, and analyse.

Sucrose content.—Taking into account the insoluble part of the substance, weigh 24·7 grammes, rub it in a mortar with little water to a smooth paste, dilute it gradually with more water and run the homogenous, thin mass, without loss, into a 100 c.cm. flask, add 2 c.cm. of subacetate of lead, fill up to the mark, mix, filter, and polarise in a 200 mm. tube; the polariscopical reading represents percentage of sucrose in the filter press cake.

For factories working with the carbonatation process it is necessary to add 8 grammes of crystallised calcium nitrate to the filter press cake before rubbing it with water in order to break up the eventually present saccharate of lime and dissolve the sucrose from that combination. This estimation is performed once every 12 hours.

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VII. SYRUP.

Sampling.—Take from each settling tank an equal quantity of syrup, pour it into a stoppered bottle, and analyse the well mixed sample once every 12 hours. After use the bottle should be washed with concentrated soda lye and afterwards with water, next the bottle is put aside in order to dry, whilst another bottle is used for the next sample. If the bottles are cleansed in this way it is unnecessary to add disinfectants to the syrup.

Determination of Sucrose and degrees Brix.—It is advisable to make the conditions in which the determination of the degrees Brix of the syrup is performed equal to those prevailing at the analysis of the mixed juice, in order to eliminate all changes occasioned by the expansion or contraction on dilution or concentration. Therefore the syrups, masse-cuites, and molasses are diluted to the concentration of the cane juice previous to their being examined with the Brix hydrometer.

In the case of syrup the dilution is from 1 to 3, so one part of syrup is diluted with two parts (in weight) of water and analysed as the first mill juice. The figures for Brix and sucrose are multiplied by 3 (the degrees Brix after correction for the temperature).

Glucose.—Is determined as described under "mixed juice," the glucose content is also found by multiplication by 3.

Alkalinity.—If necessary the alkalinity of the filter juice, clarified juice and syrup can be estimated by titration with $\frac{1}{10}$ normal acid, of which 1 c.cm. neutralises 1 milligramme of lime. Take 100 c.cm. of juice and add the standard solution from a burette, with red and blue litmus paper as an indicator. The syrup is tested after the dilution.

VIII. MASSE-CUITES.

Sampling.—The sample of first masse-cuite is taken from each pan individually during the strike and that of second masse-cuites from the basins or crystallisers just after striking.

The samples from each lot are mixed and analysed once a day.

Determination of degrees Brix and sucrose.—The degrees Brix and the sucrose are estimated as mentioned sub "Syrup" with that difference that the dilution is 5 times now. One part of masse-cuite is dissolved in 4 parts (by weight) of water and the figures obtained are of course multiplied by 5.

In view of the inferior quotient of many of the masse-cuites, the amount of subacetate of lead necessary for proper clarification is larger and may be put down like this:—

	c.cm.
For masse-cuites of ± 90	3
,, ,, ± 80	5
,, ,, ± 70	6
,, ,, ± 60	8
,, ,, ± 50	9
,, ,, ± 40	10

IX. FIRST MOLASSES.

Sampling.—For every masse-cuite one sample is taken from the discharge gutter of the centrifugals and therein determine the quotient of purity. To this end the molasses is diluted with water to the concentration of 15—18 Brix, a $\frac{110}{110}$ flask is filled with this solution to

the lower mark, the necessary amount of subacetate of lead is added, filled up to the highest mark, well shaken, filtered and polarised. When the liquid is too much coloured to be polarised in the 200 mm. tube, use the 100 mm. one and multiply the reading by two.

For molasses of ± 60 purity use 8 c.cm. of subacetate of lead.

,, ,, ± 50 ,, 9 ,, ,, ,,

,, ,, ± 40 ,, 10 ,, ,, ,,

If the liquid is too dark for even the 100 mm. tube, then the sucrose estimation is conducted as described sub "exhausted molasses." At the end of the volume will be found a table, in which the purity of the molasses is calculated, starting from the uncorrected Brix and the polarisation in the 100 mm. tube of the diluted molasses.

X. EXHAUSTED MOLASSES.

Once a day take a sample of the exhausted molasses leaving the factory, and combine the samples of 10 successive days into one sample. This is well mixed and analysed in the following way :—

Determination of Brix and Sucrose.—For the determination of the purity of first molasses we may content ourselves with the rather rough method of testing the much diluted solution, because for practical working we know for every factory what quotient of the first molasses is apt to give the best results, and utmost accuracy is not therefore wanted. This is, however, the case with the analysis of the exhausted molasses, as it is very important to know exactly how much molasses, and of what constitution, has left the factory. Weigh 500 grammes of the well-mixed sample, add 500 grammes of

water and dissolve without heating. Determine the degrees Brix of this solution, multiply by 2 and then correct for the temperature. In this case the correction for the temperature should take place after the multiplication and not before, because the coefficient of expansion of the non-sugar prevailing in the cane sugar molasses differs from that of sucrose, for which material the tables of correction are calculated. This difference happens however to become neutralised when under the circumstances indicated the correction is applied after the multiplication by 2.

Weigh 26·048 grammes of the same solution, pour them into a 100 c.cm. flask, add 10 c.cm. of subacetate of lead, fill up to the mark, shake, filter and polarise; if possible in the 200 mm. tube; if not, in the 100 mm. one. The readings either multiplied by 2 or by 4, as the case may be, give the sucrose content of the molasses.

XI. SUGAR.

Sampling.—Take from every basketful of sugar an equal portion, and mix them in a stoppered bottle.

Determination of the Sucrose.—Once a day the sample is well mixed and 26·048 grammes are weighed, conveyed into a 100 mm. flask, dissolved with water, clarified with a minimum of subacetate of lead, filled up to the mark, shaken, filtered and polarised in the 200 mm. tube. The readings directly represent percentage of sucrose.

Determination of glucose.—25 c.cm. of the same solution that has served for the polarisation are pipetted into a 100 c.cm. flask, precipitated with a solution of 5% of carbonate and 5% of sulphate of soda,

filled up with water to the mark, shaken, and filtered into a burette. With this solution 10 c.cm. of half normal test solution of copper (Fehling's test solution) are titrated as has been described sub "mixed juice." The table on page 67 shows the percentage of glucose in the sugar after the c.cm. employed in decolorising 10 c.cm. of test solution.

Determination of moisture and ash.—Tare a pair of watch glasses with the clips, and weigh 5 grammes of sugar, turn over the sugar carefully in a porcelain or platinum crucible, press it gently with the finger and add 1 c.cm. of pure sulphuric acid. Put the crucible in a hot place, the sugar becomes black, swells, and fills the crucible to the brim. Heat it in a muffle oven or over a Bunsen or spirit flame in a gas cupboard till the ash is completely white or slightly pink and all particles of carbonaceous matter are burnt.

The ash is allowed to cool in a dessicator and weighed. Cleanse the crucible with a fine brush without rubbing it too hard and weigh it again, the difference is the weight of sulphate ash in 5 grammes of sugar and is calculated on 100 parts of sugar by multiplying it by 20 and subtracting 10% as a correction for the sulphates.

The same pair of watch glasses that has served for weighing the sugar for the estimation of ash is used for the determination of the moisture.

Weigh again 5 grammes of sugar, put both glasses with the sugar open in a hot air bath in which the temperature does not rise above 103° C nor fall below 100° C, and leave it there for three hours. After that time cover the sugar with the empty glass, close both with the clip, cool in the dessicator and weigh. The difference between this weight and the original one represents the moisture in 5 grammes of sugar and is calculated on 100 parts of sugar by multiplication by 20.

Undetermined.—The balance of the sum of polarisation, glucose, ash and moisture is put down as "undetermined."

Calculation of the net sugar content.—Subtract 5 times the ash and once the glucose from the polarisation.

RECAPITULATION OF THE NECESSARY ANALYSES.

Cane.—Fibre once a day.

Bagasse.—Sucrose 24 times a day. Dry substance 12 times a day.

First Mill Juice.—Brix 24 times a day. Sucrose and quotient twice a day.

Last Mill Juice.—Brix 24 times a day. Sucrose and quotient twice a day.

Mixed Juice.—Brix 24 times a day. Sucrose and quotient twice a day. Glucose once a day.

Clarified Juice.—Brix 24 times a day. Sucrose and quotient twice a day.

Syrup.—Brix, sucrose and purity twice a day. Glucose once a day.

Filterpress Cakes.—Sucrose twice a day.

First Masse Cuite.—Brix, sucrose, quotient once a day.

First Molasses.—Quotient.

Exhausted Molasses.—Brix, sucrose, quotient once every 10 days.

Sugar.—Sucrose, net analyses once a day.

CALCULATIONS.

In order to simplify the formulæ which will be used here, I suggest the following abreviations:—

w.c.—Weight of the cane crushed.

w.b.—Weight of the bagasse.

w.j.—Weight of the mixed juice.

w.s.i.—Weight of sucrose indicated in juice.

s. extracted on 100 cane.—Sucrose in juice on 100 parts of cane.

s.c.—Sucrose in 100 parts of cane.

s.b.—Sucrose in 100 parts of bagasse.

s.b. on 100 cane.—Sucrose lost in bagasse on 100 parts of cane.

s.f.m.j.—Sucrose on 100 parts of first mill juice.

s.m.j.—Sucrose on 100 parts of mixed juice.

f.c.—Fibre on 100 parts of cane.

f.b.—Fibre on 100 parts of bagasse.

b.—Brix of the first mill juice.

b.i.—Brix of the mixed juice.

a.s.—Available sugar.

I. SUCROSE ON 100 PARTS OF CANE (*s.c.*).

The direct estimation of sucrose in cane cannot give reliable figures, owing to the nature of the cane, which makes a correct sampling impossible. Therefore we assume a factor with which the sucrose content of the first mill juice ought to be multiplied in order to yield

the average sucrose content of the cane. Usually this factor is 0·85, and does not vary much beyond 0·84 and 0·86. In single cases, when the cane contains an extraordinarily high amount of fibre, the difference is a little more. Larger deviations are due to incorrect weighing of cane, or measuring of juice, or to wrong analysis. They are a hint that something is wrong and wants rectifying.

The best method is to start with the factor 0·85, and after the first monthly or half-monthly report which shows the figures for sucrose content of cane and first mill juice, it will become apparent which figure must be used for the future.

If, however, it is thought necessary to determine the factor directly, weigh exactly 10 to 15 tons of cane, crush them in the factory mill, analyse the first mill juice, collect and weigh the resulting bagasse and determine its sucrose content. The weight and the sucrose content of the bagasse are known, and, therefore, also the weight of sucrose lost in the bagasse. The difference between the weight of the cane and that of the bagasse represents the weight of the juice, whilst its sucrose content is equally known. We calculate the weight of the sucrose of the juice, add that to the weight of sucrose in the bagasse, and so find the weight of the sucrose in the weight of canes crushed, and can calculate the sucrose content on 100 parts of cane. We know the sucrose content of the first mill juice, and thus can calculate the factor which we want.

The value of that factor for different fibre contents and different extraction may be found on page 72.

The figure for the sucrose content of the cane thus calculated is only an average one, and by no means rigorously accurate. It is, therefore, not available as a basis for chemical control, but only

serves to show day by day, approximately, how much cane has been crushed in the preceding 24 hours. This figure and its derivates may not be used in later reports than this daily one. The formula is:—

$$s.c. = s.f.m.j. \times \text{Factor.}$$

II. SUCROSE LOST IN BAGASSE ON 100 PARTS OF CANE (*s.b. on 100 cane*).

This figure is derived from the fibre content of cane and bagasse and the sucrose of the latter. It is not absolutely right, since we assume that no fibre is carried along with the juice. We content ourselves with calculating how much sucrose is lost on one part of fibre, and next find from the fibre content of the cane the amount of sucrose lost on so much fibre as is equivalent to 100 cane according to the formula:—

$$f.b. : s.b. = f.c. : x \qquad x \text{ or } s.b. \text{ on } 100 \text{ cane} = \frac{s.b.\ f.c.}{f.b.}$$

III. SUCROSE IN JUICE ON 100 CANE (*s. extracted on 100 c.*).

Subtract the figure for sucrose lost in bagasse on 100 cane from the sucrose content of the cane. As we showed that the figure for the sucrose in the cane is only an approximative one, the figure for sucrose extracted on 100 cane is neither absolutely accurate, and will in the final reports be replaced by a more reliable one. The formula is:—

$$s. \text{ extracted on } 100 \text{ cane} = s.c. - s.b. \text{ on } 100 \text{ cane.}$$

IV. WEIGHT OF SUCROSE INDICATED IN JUICE (*w.s.i.*).

This figure representing the weight of sucrose entering in juice into the manufacture is the basis of the control, and therefore must be determined every day with the utmost care. Reliable weighing

machines are as yet not invented, and we are compelled to have recourse to the old measuring tanks. It is important that these tanks be well graduated, and that the layer of foam on the surface of the juice and the expansion of material owing to the high temperature of the juice be well taken into account. Further, great care must be taken that the tanks always get well filled and their number accurately stated. Finally the sampling and the analysis of of the mixed juice require the continual supervision of the man in charge.

The weight of the juice is derived from the volume after the method described on page 39.

Multiply the weight of the mixed juice with its sucrose content and divide by 100 in order to find the weight of sucrose entering in the juice into the factory, after the formula :—

$$w.s.i. = w.j. \times \frac{s.m.j.}{100}$$

V. WEIGHT OF AVAILABLE SUGAR (*a.s.*)

This figure should also be calculated every day and entered in the laboratory books in order to ascertain day by day if the amount of sugar expected after the analysis is really present in the shape of finished or half-finished product.

After a series of experiments made in well equipped Java factories, it became evident that the sugar obtained in regular working could be represented by the formula :—

a.s. on 100 parts of mixed juice=*s.m.j.*—0·4 (*b.i.*—*s.m.j.*).

In this shape the formula serves for the calculation of the sugar available from 100 parts of mixed juice, but for the calculation of the sugar available from 100 cane, or from a given quantity of

sucrose present in a juice of a given quotient it may be simplified like this:—

$$a.s. = \left\{ s.m.j. - 0{\cdot}4\,(b.i. - s.m.j.) \right\} \times \frac{w.s.i.}{s.m.j.}$$

$$a.s. = \frac{w.s.i. \times (s.m.j. - 0{\cdot}4\ b.i. + 0{\cdot}4\ s.m.j.)}{s.m.j.}$$

$$a.s. = 1{\cdot}4\ w.s.i. - 0{\cdot}4\,\frac{w.s.i. \times b.i.}{s.m.j.}$$

$\frac{100 \times s.m.j.}{b.i.}$ = quotient of mixed juice: if we substitute this value in the above equation, we have:—

$$a.s. = 1{\cdot}4\ w.s.i. - 40\,\frac{w.s.i.}{quotient}$$

$$a.s. = w.s.i. \times \left(1{\cdot}4 - \frac{40}{quotient}\right).$$

The weight of available sugar may, therefore, be found by multiplying every day the weight of sucrose indicated in juice with the factor $1{\cdot}4 - \frac{40}{quotient}$ in which *quotient* is the quotient of purity of the mixed juice during that same day.

The value of the factor $1{\cdot}4 - \frac{40}{quotient}$ is already calculated for every degree of purity in the table on page 69, whilst the logarithms needed may be found on pages 70 and 71.

VI. AVAILABLE SUGAR ON 100 CANE.

Multiply the figure for sucrose extracted on 100 cane with the factor $1{\cdot}4 - \frac{40}{quotient}$. For values see page 69.

We have already observed that the value "*s.* extr. on 100 cane" is not absolutely sure, in consequence of which the value for the available sugar on 100 cane derived from it is also only approximate. It may not be used as a starting point for the control, but only serves in the daily report to give an idea of the constitution of the cane crushed that day.

VII. NORMAL JUICE.

"Normal juice" is the denomination used for the ideal juice, which we fancy we have extracted from the cane by all the mills without reckoning the maceration water, thus representing the mixed juice without the dilution owing to maceration. Formerly we used to consider the first mill juice as the normal juice. This is, however, obviously wrong, since the second and third mills extract a much poorer juice than the first one, even without maceration. In order to correct this it is much better to assume for the composition of the normal juice a juice having the Brix of the first mill juice, and the quotient of purity of the mixed juice. The figures are, therefore, as follows:—

$$\textit{Brix normal juice} = \textit{Brix first mill juice.}$$

$$\textit{Sucrose normal juice} = \frac{\textit{Brix first mill juice} \times \textit{Quotient mixed juice}}{100}$$

$$\textit{Quotient normal juice} = \textit{Quotient mixed juice.}$$

When the cane is crushed two or more times without maceration this calculation is of course superfluous, and the composition of the normal juice is identical with that of the mixed juice.

The composition of the normal juice is only required for the calculation of the amount of normal juice extracted per 100 cane; if this figure is not wanted, the calculation of the composition of the normal juice may be likewise omitted.

VIII. CALCULATED WEIGHT OF CRUSHED CANE (*w.c.*)

The weight of the cane crushed serving for the basis of the control is obtained by direct weighing of the canes carried into the factory, but because the canes in the milling house are not finished every day, and a larger or smaller store remains before the mill, the direct

weighing cannot tell us how much cane has been crushed in the foregoing 24 hours. Yet it is necessary to know that, and therefore we calculate the weight of the canes crushed after a somewhat rough method, which may differ from the truth 2% on either side. This difference is insignificant if one only wants to know the figure of cane worked up in a day, but it is too considerable to use it as a basis for the chemical control.

The weight of cane crushed is calculated from the weight of sucrose indicated in juice and the percentage of sucrose extracted on 100 cane after the formula :—

$$w.c. = \frac{w.s.i.}{s.\ extracted\ on\ 100\ cane} \times 100.$$

IX. EXTRACTION.

This figure represents the proportion between the sucrose extracted and the sucrose present in the cane, and can be found by dividing 100 × the sucrose extracted on 100 cane by the percentage of sucrose in the cane like this :—

$$Extraction = \frac{s.\ extracted\ on\ 100\ cane \times 100}{s.c.}$$

X. DILUTION BY MACERATION.

Under the denomination "Dilution" we understand the quantity of water added during maceration to 100 parts of normal juice. Its value is calculated from the degrees Brix of both first mill juice and mixed juice, as that calculated from their sucrose contents is not so accurate. Assuming that the total amount of dry substance does not undergo any change by the dilution, as the maceration water does not contain dissolved matter, we know that the dry substance in the mixed juice comes exclusively from the normal juice. Now we calculate

how many parts of mixed juice of a given Brix are required to contain as much dry substance as 100 parts of normal (first mill) juice of a certain Brix.

$$x\ b.i. = 100\ b.$$

$$x = \frac{b.}{b.i.} \times 100$$

Of these 100 $\frac{b.}{b.i.}$ parts of mixed juice, 100 parts are the original normal juice and the balance is the water added by the maceration; in order to find this we subtract 100 and the formula becomes like this:—

$$\text{Dilution by maceration} = 100\,\frac{b.}{b.i.} - 100 \text{ or } = 100\left(\frac{b.}{b.i.} - 1\right)$$

XI. PERCENTAGE OF NORMAL JUICE EXTRACTED ON 100 CANE.

Although this figure, owing to considerable fluctuations in the fibre content of the cane, is not apt to yield a good insight in the crushing power of the mills and in this respect remains behind the figures for loss of sucrose in the bagasse on 100 cane or for the extraction, some mill owners still want it recorded and therefore the calculation is given here.

The quantity of sucrose extracted in juice on 100 cane is already calculated and equally the sucrose content of the normal juice is known, so a simple equation yields the percentage of normal juice extracted per 100 cane:—

s.f.m.j. : 100 = *s. extraction on* 100 *cane* : x

x or *percentage of normal juice extracted from* 100 *cane* =

$$\frac{s.\ extracted\ on\ 100\ cane}{s.f.m.j.} \times 100.$$

XII. WEIGHT OF SUCROSE LOST IN BAGASSE AND IN FILTER PRESS CAKES.

With a view to diminishing the calculating work for the fortnightly or monthly reports, and so simplifying the supervision of this work, it is advisable to calculate day for day, besides the weight of sucrose entered into the factory and that of the available sugar, also the weight of sucrose lost in the bagasse and in the filter-press cakes. The sucrose lost in bagasse on 100 cane is already known (*s.b. on 100 cane*) as well as the weight of cane crushed (*w.c.*), so that the formula for the weight of sucrose in bagasse is:—

$$\textit{Weight of sucrose lost in bagasse} = \frac{w.c. \times s.b.\ on\ 100\ cane}{100}$$

The sum of *w.c.* and $w.c. \times \frac{s.b.\ on\ 100\ cane}{100}$ represents the weight of sucrose entered into the mill in the cane, a figure which will afterwards be used in the final sucrose balance.

In the same way the sucrose lost in filter-press cakes is calculated from the weight and the sucrose content of the cakes or mud.

XIII. WEIGHT OF SUCROSE IN RETURNED SUGAR.

Sometimes sugar or seconds are returned into the juice. In this case these products should be weighed and analysed, and the weight of sucrose returned in the course of manufacture should be calculated and recorded.

XIV. CENTRIFUGAL OUTCOME.

In most cases molasses are returned into the pan when boiling first sugar, which renders the direct estimation of the sugar extracted from 100 parts of original masse-cuite impossible. When we assume that the molasses returned only serve to liquify the mass and do not part

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with any more sugar themselves, the centrifugal outcome of the first masse-cuite can be calculated in an indirect but reliable way, starting from the quotients of the syrup, the molasses and the sugar.

Let us consider first all these constituents in an anhydrous state and suppose the amount of dry marketable sugar from 100 parts of dry masse-cuite to be x, then the quantity of molasses $= 100 - x$, and we form the following equation :—

$x \times$ *quotient of sugar* $+ (100 - x) \times$ *quotient of molasses* $= 100$ *quotient masse-cuite.*

$x \times$ (*quotient sugar* $-$ *quotient molasses*) $= 100 \times$ (*quotient masse-cuite* $-$ *quotient molasses*).

$$x = \frac{100 \times \textit{quotient masse-cuite} - \textit{quotient molasses}}{\textit{quotient sugar} - \textit{quotient molasses}}$$

This formula is only calculated for the anhydrous constituents; if we want it for the constituents with their proper amount of moisture the equation is as follows :—

Centrifugal outcome $=$

$$100 \times \frac{\textit{quotient masse-cuite} - \textit{quotient molasses}}{\textit{quotient sugar} - \textit{quotient molasses}} \times \frac{\textit{Brix masse-cuite}}{\textit{Brix sugar}}$$

When we substitute the value for quotient of masse-cuite by that for the value of the quotient of syrup or clarified juice, we can also calculate how much sugar was obtained from 100 parts of any given quantity of syrup or juice of a certain constitution, provided no technical losses have taken place by spilling or leaking.

RECAPITULATION OF THE DAILY CALCULATIONS.

Sucrose on 100 cane. $s.c. = s.f.m.j. \times factor.$

Sucrose lost in bagasse on 100 cane. $s.b.\ on\ 100\ cane = s.b. \frac{f.c.}{f.b.}$

Sucrose in juice on 100 cane. $s.\ extraction\ on\ 100\ cane = s.c. - s.b.\ on\ 100\ cane.$

Weight of sucrose entered in juice. $w.j. \times \frac{s.m.j.}{100}$

Weight of available sugar. $a.s. = w.s.i. \times \left(1{\cdot}4 - \frac{40}{quotient}\right)$

Available sugar on 100 cane. $a.s.\ on\ 100\ cane = s.\ extr.\ on\ 100\ cane \times \left(1{\cdot}4 - \frac{40}{quotient}\right).$

Sucrose in normal juice. $s.n.j. = \frac{b. \times quotient\ mixed\ juice}{100}$

Weight of cane. $w.c. = \frac{w.s.i.}{s.\ extr.\ on\ 100\ cane} \times 100$

$Extraction = \frac{s.\ extr.\ on\ 100\ cane}{s.c.} \times 100$

Dilution by maceration. $100\left(\frac{b.}{b.i.} - 1\right)$

Percentage of normal juice extracted on 100 cane.

$$\frac{s.\ extr.\ on\ 100\ cane}{s.f.m.j.} \times 100$$

Weight of sucrose lost in bagasse $= w.c. \times \frac{s.b.\ on\ 100\ cane}{100}$

Weight of sucrose lost in filter press cakes $=$ *weight of cakes* $\times$ $\frac{sucrose\ in\ 100\ cakes}{100}$

Weight of sucrose in returned seconds $=$ *weight of returned sugar* $\times$ $\frac{sucrose\ in\ 100\ returned\ sugar}{100}$

Centrifugal outcome $= 100 \times \frac{quotient\ masse\text{-}cuite - quotient\ molasses}{quotient\ sugar - quotient\ molasses} \times \frac{Brix\ masse\text{-}cuite}{Brix\ sugar}$

PART II.

MONTHLY REPORT.

ANALYSES.

The figures from the daily report A. are entered into books B. and C. in order to serve as material for the compilation of the monthly report. Some prefer to make this report every week or every ten days, others once a fortnight or month, but for convenience sake in this treatise only, the term monthly report is mentioned without attaching too much significance to the word "monthly" because a weekly report is calculated in exactly the same way.

I. CANE.

(*a.*) *Weight of the Cane.*—The weight of the cane crushed is taken to be the weight of the cane entered into the factory yard after deduction of the weight of the cane still left uncrushed at the moment of the date of the report.

(*b.*) *Sucrose.*—In this report the value s.f.m.j. × Factor may no longer be used, as this was only tolerated in practical use for a rather rough estimation of the constitution of the cane. Add the weight of sucrose entered in juice into the factory to the weight of sucrose lost in bagasse during the month and divide that sum by the weight of the canes crushed, after which the quotient is to be multiplied by 100.

This same calculation is repeated with the total weight of the sucrose from the beginning of the grinding season in order to have the average for the whole grinding time as well.

(*c.*) *Fibre.*—This figure may be calculated by dividing the sum of the percentages by the number of observations.

II. BAGASSE.

(*a.*) *Sucrose.*—When calculating the total weight of sucrose lost in bagasse a small correction is necessary. The daily figures for that value have relation to the calculated weight of cane crushed, and since we saw that this differs from the actual weight of the cane it requires a small correction. To that end the total amount of sucrose lost in bagasse during the month as recorded in the Book B. is to be multiplied with the actual weight of the cane crushed that month and divided by the calculated weight, the resulting quotient is then the actual weight of sucrose lost in the month under review in bagasse.

The fibre content may be calculated as is described on page 7. The calculation is based on the average dry substance and the sucrose content of the bagasse and the average purity of the last mill juice during the month.

III. FIRST AND LAST MILL JUICE, CLARIFED JUICE SYRUP, FIRST AND SECOND MASSE-CUITES.

With the above products, none of which form fixed points for the control we can content ourselves with calculating the average by dividing the sum of the daily figures by the number of days.

IV. MIXED JUICE.

As the mixed juice is the starting point of the control it is necessary that the figures for that material be recorded with the utmost care. The best method is the following: add up the weights of sucrose entered in juice during the period under review, and do the same thing for the weight of the mixed juice and for the weight of available sugar. Now divide the weight of sucrose indicated in juice by the weight of

mixed juice and multiply by 100 in order to obtain the percentage of sucrose in mixed juice during that time. Further divide the weight of calculated available sugar by the weight of sucrose indicated in juice and multiply by 100. The resulting product is 100 times the factor of $1{\cdot}4-\frac{40}{quotient}$ and herefrom the quotient of the mixed juice may be found by using a table in which the proportion of the factor and the quotient is recorded. From the figures of sucrose and quotient the average Brix of the mixed juice is easily found. The glucose content can be calculated by simply dividing the sum of the daily figures by the number of observations.

V. FILTER PRESS CAKES.

Of this material a well calculated average is required, which may be obtained by dividing 100 times the weight of sucrose lost in filter press cakes during the period under review by the weight of the cakes themselves discharged during the time.

VI. SUGAR DELIVERED, SECOND SUGARS, SUGAR RETURNED INTO THE JUICE.

For all these products the sum of sucrose contained in them is to be divided by the weight of every product and multiplied by 100 in order to yield the average sucrose content of these materials.

VII. MOLASSES.

The molasses drained off from the last product in the centrifugals can be easily measured and analysed. From the specific gravity and the sucrose content the quantity of sucrose removed from the manufacture can be calculated and noted in the list.

VIII. MACERATION WATER.

Calculate the quantity of imbibition water from the degrees Brix of first-mill juice and mixed juice after the formula developed below. Suppose the weight of maceration water = x, then the weight of normal juice is w.j. – x, and as the weight of total dry substance in both juices is the same, we have this equation:—

$$w.j. \times b.i. = (w.j. - x) \times b.$$

$$w.j. \times b.i. = b. \times w.j. - b. \times x.$$

$$x = w.j. \times \frac{b. - b.i.}{b.}$$

IX. PERCENTAGE OF NORMAL JUICE EXTRACTED ON 100 CANE.

In the monthly report this value is calculated by multiplying the weight of normal juice (w.j. – maceration water) by 100 and dividing by the weight of the cane crushed. This was not feasible when calculating the daily report, and therefore another way of calculating the quantity of normal juice extracted on 100 cane was followed there.

Both figures are calculated from different values, having each their source of error, and thus they cannot be expected to give identical results. If the two figures, however, differ considerably, then it is an indication that something is wrong and wants correcting.

X. EXTRACTION.

The same calculation as sub "daily report."

PART III.

FINAL ACCOUNT OF SUCROSE EXTRACTED AND LOST.

LABORATORY REQUIREMENTS.

FINAL ACCOUNT OF SUCROSE EXTRACTED AND LOST.

At the conclusion of the grinding season and also occasionally after a stoppage which allowed the stock of cane to be worked off, the final account can be made of the profit and loss of the sucrose from the cane. The total weights of sucrose in cane, in bagasse, in mixed juice, in filter press cakes, and in molasses are known and are entered in the A. Form provided. By multiplying by 100 and dividing by the weight of the canes crushed, these are further calculated on 100 parts of cane and finally the remaining blanks may be filled in for the different products.

If e.g. a quantity of 594,749 piculs of mixed juice were recorded with 81,481 piculs of sucrose, the sucrose content of that juice would have been: $\frac{81481 \times 100}{594749}$ and so on.

The figure for "unaccounted for" loss is found by subtracting the determined losses from the total loss.

Finally, calculate all weights by multiplying by 100 and dividing by the figure for weight of sugar indicated in the cane into the value for sucrose lost and gained on 100 parts of sugar in cane, and fill them in in the proper column.

VERIFICATION OF MEASURING TANKS AND INSTRUMENTS.

1. MEASURING TANK.

First of all determine the contents of the 50 litres measure by filling it to the brim with water of the prevailing temperature, then weigh it on the sugar delivery scale, empty it and weigh it again still moist with the adhering water. The difference in weight represents the weight in kilogrammes or pounds of the water measured by it at the temperature prevailing in the factory.

Now fill the measuring tank with water, empty it and fill it, still wet, with water to the mark, first with the verified 50 litres measure and the last portions with a litre flask. The temperature of the water should of course be the same as when verifying the measure.

The weight of the water occupied by the tank at say T degrees C. is calculated on the weight of water of 17·5° C. which the tank can contain by multiplying the weight

for 25° C. with 1·0016
for 26° C. with 1·001
for 27° C. with 1·00215
for 28° C. with 1·0024
for 29° C. with 1·0027
for 30° C. with 1·0030
for 31° C. with 1·0033

and thus find the capacity of the measuring tank expressed in weight of water at 17·5° C., which has only to undergo a further correction for the volume of included air and froth.

A few times during the grinding season fill the measuring tank in the ordinary way to the mark and leave the juice till the froth is settled, the bubbles of enclosed air have escaped and the temperature of the warm juice is fallen to the temperature at which the tank had been previously verified. Add juice from litre flasks into the tank till the surface has reached the mark again and note the amount of juice required; this is the correction for scum, air, and increased temperature. Suppose it had required 1·5% of the volume to compensate for the shrinkage, then we can correct the determined weight of the water at 17·5° C. by multiplying it with 0·985. This figure is used for the calculation of the weight of the mixed juice, without further correction, as all corrections are already incorporated in it.

The weight of the juice daily measured becomes like this:—

Suppose the specific gravity of water of 17·5° C. to be=1. Next note during some consecutive days the temperature of the mixed juice and calculate the average. Suppose this temperature to be 31° C. and the corrected Brix—(*i.e.*, the average Brix which a Brix hydrometer verified at 17·5° C. would show in the juice cooled down to 17·5° C.) of a certain day to be 15·93, then the average Brix of that day calculated on the prevailing average temperature is according to the table of correction 15·93 − 0·94=14·99, corresponding with a specific gravity of 1·0163.

The weight of the juice measured=the weight of the water at 17·5° C. corresponding with the number of tanks × the specific gravity of the juice at 31° C.

2. MEASURING FLASKS FOR THE POLARISATION.

The generally used Schmidt and Haensch polariscopes are so constructed that they show the 100 point, when 26·48 grammes of dry

and perfectly pure sucrose weighed in the air and with brass weights are dissolved at 17·5° C. in water to a volume of 100 c.cm. after Mohr and polarised at that same temperature in a 200 mm. tube.

The flasks used for dissolving sugar solutions for the polariscopical test must therefore be graduated and verified at the temperature of 17·5° C., and must be based on the specific gravity of water of 17·5° C. = 1 as the c.cm. after Mohr means volume of 1 gramme of water at 17·5° C. weighed in the air with brass weights.

When verifying a 100 c.cm. flask we therefore weigh in the dry flask in the air with brass weights at the temperature of 17·5° C. exactly 100 grammes of water of that same temperature and mark the place where the water stands in the neck. As, however, the temperature of the tropics renders this operation at 17·5° C. impossible, or at least troublesome, a table of the weight of water of different temperatures also weighed in the air with brass weights is given below in order to enable the verification of the flasks at other than 17·5° C.

Temperature.	Weight of 50 c.cm. after Mohr. 17·5° = 1.	Weight of 100 c.cm. after Mohr. 17·5° = 1.
25° C.	49·916	99·833
25·5° ,, ...	49·910	99·820
26° ,, ...	49·903	99·807
26·5° ,, ...	49·896	99·793
27° ,, ...	49·890	99·780
27·5° ,, ...	49·883	99·767
28° ,, ...	49·877	99·754
28·5° ,, ...	49·870	99·740
29° ,, ...	49·863	99·727
29·5° ,, ...	49·857	99·714
30° ,, ...	49·850	99·701

Of late years the real c.cm. has been adopted again for the measuring flasks. It contains one gramme of water at 4°C. weighed in vacuo, and is thus smaller than c.cm. after Mohr.

The standard weight for such flasks is accordingly smaller, and amounts to 26 grammes of pure and dry sucrose, weighed in the air with brass weights.

The weight of water at different temperatures of 50 and 100 real c.cm. is recorded here :—

Temperature.	Weight of 50 real c.cm. 4° = 1.	Weight of 100 real c.cm. 4° = 1.
25° C.	49·802	99·604
25·5° ,,	48·796	99·591
26° ,,	49·789	99·578
26·5 ,,	49·783	99·565
27° ,,	49·776	99·551
27·5° ,,	49·769	99·537
28° ,,	49·762	99·523
28·5° ,,	49·754	99·509
29° ,,	49·747	99·494
29·5° ,,	49·740	99·480
30° ,,	49·733	99·465

Flasks of 50/55 and 100/110 used for juice after addition of subacetate of lead need not exactly contain 50 or 100 c.cm.; the only thing required is that the volume between the two marks be exactly $\frac{1}{10}$ of the volume under the lowest mark.

3. PIPETTES.

The best are those with two marks; verify them by the direct weighing of the contents between the two marks.

For pipettes of 100 or 50 c.cm. a difference of 0·1 % is tolerated; for smaller ones, one of 0·25 %.

4. BRIX HYDROMETERS.

The Brix hydrometers are based on the specific gravity of water at 17·5° C. = 1. Every factory should be equipped with one set of well controlled hydrometers used as standards only in order to verify those in practical use in the laboratory. If perhaps hydrometers of 17·5° C. are not at hand, those of another standard temperature may as well be used, provided a correction be applied. Suppose we test a sample juice with two hydrometers, A. and B. of which A. is based on the temperature 17·5°, and B. 27·5° C. The temperature of the juice is supposed to be 30° C., then if the readings of A. are 14·62, the real Brix is 14·62 + 0·87 = 15·49, and B. will show 15·3, or a real Brix of 15·3 + 0·19 = 15·49 or the same figure. Both hydrometers give after their proper correction the same Brix, which may however not be used for the finding of the sucrose content of juices after Schmitz's tables as these require the uncorrected Brix, *i.e.*, the Brix of the moment of the preparing for the polarisation. In order to come back to the uncorrected Brix as recorded by a hydrometer tested at 17·5° C., we subtract from the corrected Brix the same value, which ought to have been added when the hydrometer had been tested at 17·5° C., thus in our case 0·87. We find for the uncorrected Brix 15·49 – 0·87, and use that value for the finding of the sucrose content by means of Schmitz's table.

5. POLARISCOPE.

Verify every day the polariscope with the tube filled with water and with control quartz plates, which ought to be submitted every four or five years to a technical institute for examination.

INSTRUMENTS AND UTENSILS REQUIRED FOR THE EXECUTION OF THE ANALYSES MENTIONED IN THIS TREATISE.

1. A laboratory three-roller test mill of strong construction.

2. Two dry air baths with double wells, capacity 20 c.dm. (1220·5 cubic inches.)

3. Three extraction apparatuses after Soxhlet for the determination of fibre in cane, made of glass or copper plate, having a sufficient capacity for holding 10 grammes of bagasse or 20 grammes of cane; with three baskets of centrifugal gauze having sufficient capacity to hold ten grammes of bagasse.

4. A refrigerator to condense the alcohol vapours from the above mentioned extracting apparatuses.

5. Eight tared cylinders of copper or tin for the sucrose estimation in bagasse, capacity 1 or 1½ c.dm.

6. Ten tared shallow dishes of tin or copper for the determination of moisture in bagasse, surface 1·5 sq. dm., height 3 cm.

7. Brix hydrometers tested at 17·5° C. provided with a thermometer:—

Five of 0 — 19 degrees Brix.
Six of 10 — 20 ,,
Two of 20 — 30 ,,
Two of 40 — 60 ,,

8. Two Beaumé hydrometers for weighing the lime cream.

9. Three pyknometers with or without thermometer; capacity 50 c.cm.

10. A polariscope with single or double quartz edge compensation, for 400 mm. tubes (half shadow).

11. A control quartz plate $\pm$ 98.
,, ,, $\pm$ 50.

12. Six tubes of 400 mm.
Twelve ,, 200 mm.
Two ,, 100 mm.

13. A lamp for the polariscope, for kerosene oil, acetylene or gas.

14. A good stock of rubber ringlets and cover plates for the observation tubes of the polariscope.

15. An analytical balance, capacity 200 grm., sensitiveness $\frac{1}{2}$ mgr.

16. Balance for weighing the sugar for the polarisation; capacity 500 grammes, sensitiveness 5 mgr.

17. A technical balance; capacity 5 kilos, sensitiveness 100 mgr.

18. A decimal balance, capacity 25 kilos.

19. Weights; for every balance a complete set.

20. Normal weights for the sugar polarisation. 52·096, 26·048 and 13·024 gr.

21. Two dishes of German silver after Scheibler with funnels.

22. A large and a small size dessicator.

23. Twelve copper cylinders with discharge tube for decanting juice samples.

24. Twelve tin cylinders provided with a sieve of wire gauze for collecting juice samples.

25. Measures for lime cream :—

Two of 2 litres
Two of 1 litre
Two of ½ litre.

26. Three copper beakers with spout for the dilution of molasses.

27. Two thermometers of 0 — 200° C.
,, ,, 0 — 100° C.

28. Ten glass cylinders for the determination of Brix with the hydrometer.

29. Sixteen cylinders with spout for receiving the filtered, clarified juices to be polarised.

Ten cylinders without spout.

30. Sixteen glass funnels for filtration of clarified juices, diameter 9 cm.

Two glass funnels diameter 16 cm.
,, ,, ,, 24 cm.

31. Cylindrical measures tested at 17·5° C.

Two each of 1,000, 500, 250, 50 and 25 c.cm.

32. Ten measure flasks $\frac{1}{110}$.

Five ,, ,, 100 c.cm. verified at 17·5° C.

33. Two measure flasks verified at 17·5° C. each respectively of 1,000, 500, 250 c.cm.

34. Four burettes of 50 c.cm. divided in $\frac{1}{10}$ c.cm. (17·5° C.).

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35. Twelve Erlemeyer ballons for the determination of the glucose.

36. Pipettes verified at 17·5° C.

    Two each of 100 and 50 c.cm., four each of 25, 10 and 5 c.cm. respectively.

37. Fifty test tubes, 20 with 150 mm.

38. Six copper methylated spirit lamps.

39. Two water baths with copper or porcelain rings.

40. A good quantity of filtering paper.

41. A measure of 50 litres.

42. Sharp chopping knives.

43. Stoppered bottles of two litres capacity for collecting samples.

Further, a well-equipped laboratory should possess:—

A set of bottles for test solutions with enamelled label, wood supports for test tubes and pipettes, dropping glasses, washing flasks, clamps, tweezers, spatulæ and spoons, files, cork borers, cork squeezers, scissors, destruction ballons after Kjehldahl, distillation flasks, spat bulbs, coolers, rubber tubes and stoppers of different sizes, and Kipp's apparatus, washing bottles for gas, beakers, funnels. porcelain basins and crucibles, a Barthel lamp for alcohol, copper wire gauze, asbestos plates with and without aperture, tripods, clay triangles, crucible tongs, test tube holders, glass rods and tubes, mortars, watch glasses with clips, weighing flasks, iron supports with their clamps and rings, filter supports, &c., and a well-assorted stock of chemicals.

NATIVE ASSISTANCE.

The exact execution of the analyses and calculations mentioned in the foregoing pages requires the assistance of a well-trained staff of native helpers. Two shifts each consisting of two assistants have proved sufficient for the regular analyses during day and night; one of these men analyses the juices and the other the bagasse, filter press cake, &c. Further, a fifth assistant only working during day time examines the field and factory samples of the cane, the molasses, the fibre contents, &c.

The execution of the analyses and determinations in this treatise has been rendered so simple that the European chemist need not occupy himself with them and only exercises a general supervision. An important factor is the strict rule, that the juices in which the Brix has been determined, and the tubes which have served for the polariscopical test, remain untouched for a certain time, in order to enable the chemist to verify at any unexpected moment the results entered in the books with his own observation of the same sample. Only the most important determinations, such as polarisation of sugar delivered, &c., need be trusted to the personal care of the European chemist instead of to his assistants.

PART IV.

TABLES.

1. TABLE FOR THE COMPARISON OF DEGREES BRIX AND SPECIFIC GRAVITY AT 17·5 C.

	0	1	2	3	4	5	6	7	8	9
0	1·00000	1·00038	1·00077	1·00116	1·00155	1·00193	1·00232	1·00271	1·00310	1·00349
1	1·00388	1·00247	1·00466	1·00505	1·00544	1·00583	1·00622	1·00662	1·00701	1·00740
2	1·00779	1·00818	1·00858	1·00897	1·00936	1·00976	1·01015	1·01055	1·01094	1·01134
3	1·01173	1·01213	1·01252	1·01292	1·01332	1·01371	1·01411	1·01451	1·01491	1·01531
4	1·01570	1·01610	1·01650	1·01690	1·01730	1·01770	1·01810	1·01850	1·01890	1·01930
5	1·01970	1·02010	1·02051	1·02091	1·02131	1·02171	1·02211	1·02252	1·02292	1·02333
6	1·02373	1·02413	1·02454	1·02494	1·02535	1·02575	1·02616	1·02657	1·02697	1·02738
7	1·02779	1·02819	1·02860	1·02901	1·02942	1·02983	1·03024	1·03064	1·03105	1·03146
8	1·03187	1·03228	1·03270	1·03311	1·03352	1·03393	1·03434	1·03475	1·03517	1·03558
9	1·03599	1·03640	1·03682	1·03723	1·03765	1·03806	1·03848	1·03889	1·03931	1·03972
10	1·04014	1·04055	1·04097	1·04139	1·04180	1·04222	1·04264	1·04306	1·04348	1·04390
11	1·04431	1·04473	1·04515	1·04557	1·04599	1·04641	1·04683	1·04726	1·04768	1·04810
12	1·04852	1·04894	1·04937	1·04979	1·05021	1·05064	1·05106	1·05149	10·5191	1·05233
13	1·05276	1·05318	1·05361	1·05404	1·05446	1·05489	1·05532	1·05574	1·05617	1·05660
14	1·05703	1·05746	1·05789	1·05831	1·05874	1·05917	1·05960	1·06003	1·06047	1·06090
15	1·06133	1·06176	1·06219	1·06262	1·06306	1·06349	1·06392	1·06436	1·06479	1·06522
16	1·06566	1·06609	1·06653	1·06696	1·06740	1·06783	1·06827	1·06871	1·06914	1·06958
17	1·07002	1·07046	1·07090	1·07133	1·07177	1·07221	1·07265	1·07309	1·07358	1·07397
18	1·07441	1·07485	1·07530	1·07574	1·07618	1·07662	1·07706	1·07751	1·07795	1·07839
19	1·07884	1·07928	1·07973	1·08017	1·08062	1·08106	1·08151	1·08196	1·08240	1·08285
20	1·08329	1·08374	1·08419	1·08464	1·08509	1·08553	1·08599	1·08643	1·08689	1·08733
21	1·08778	1·08824	1·08869	1·08914	1·08959	1·09004	1·09049	1·09095	1·09140	1·09185
22	1·09231	1·09276	1·09321	1·09367	1·09412	1·09458	1·09503	1·09549	1·09595	1·09640
23	1·09686	1·09732	1·09777	1·09823	1·09869	1·09915	1·09961	1·10007	1·10053	1·10099

24	1·10145	1·10191	1·10237	1·10283	1·10329	1·10375	1·10421	1·10468	1·10514	1·10560
25	1·10607	1·10653	1·10700	1·10746	1·10793	1·10839	1·10886	1·10932	1·10979	1·11026
26	1·11072	1·11119	1·11166	1·11213	1·11259	1·11306	1·11353	1·11400	1·11447	1·11494
27	1·11541	1·11588	1·11635	1·11682	1·11729	1·11776	1·11824	1·11871	1·11918	1·11965
28	1·12013	1·12060	1·12107	1·12155	1·12202	1·12250	1·12297	1·12345	1·12393	1·12440
29	1·12488	1·12536	1·12583	1·12631	1·12679	1·12727	1·12775	1·12823	1·12871	1·12919
30	1·12967	1·13015	1·13063	1·13111	1·13159	1·13207	1·13255	1·13304	1·13352	1·13400
31	1·13449	1·13497	1·13545	1·13594	1·13642	1·13691	1·13740	1·13788	1·13837	1·13885
32	1·13934	1·13983	1·14032	1·14081	1·14129	1·14178	1·14227	1·14276	1·14325	1·14374
33	1·14423	1·14472	1·14521	1·14570	1·14620	1·14669	1·14718	1·14767	1·14817	1·14866
34	1·14915	1·14965	1·15014	1·15064	1·15113	1·15163	1·15213	1·15262	1·15312	1·15362
35	1·15411	1·15461	1·15511	1·15561	1·15611	1·15661	1·15710	1·15760	1·15810	1·15861
36	1·15911	1·15961	1·16011	1·16061	1·16111	1·16162	1·16212	1·16262	1·16313	1·16363
37	1·16413	1·16464	1·16514	1·16565	1·16616	1·16666	1·16717	1·16768	1·16818	1·16869
38	1·16920	1·16971	1·17022	1·17072	1·17132	1·17174	1·17225	1·17276	1·17327	1·17379
39	1·17430	1·17481	1·17532	1·17583	1·17635	1·17686	1·17737	1·17789	1·17840	1·17892
40	1·17934	1·17995	1·18046	1·18098	1·18150	1·18201	1·18253	1·18305	1·18357	1·18408
41	1·18460	1·18512	1·18564	1·18616	1·18668	1·18720	1·18772	1·18824	1·18877	1·18929
42	1·18981	1·19033	1·19086	1·19138	1·19190	1·19243	1·19295	1·19348	1·19400	1·19453
43	1·19505	1·19558	1·19611	1·19663	1·19716	1·19769	1·19822	1·19875	1·19927	1·19980
44	1·20033	1 20086	1·20139	1·20192	1·20245	1·20299	1·20352	1·20405	1·20458	1·20512
45	1·20565	1·20618	1·20672	1·20725	1·20779	1·20832	1·20886	1·20939	1·20993	1·21046
46	1·21100	1·21154	1·21208	1·21261	1·21315	1·21369	1 21423	1·21477	1·21531	1·21585
47	1·21639	1·21693	1·21747	1·21802	1·21856	1·21910	1·21964	1·22019	1·22073	1·22127
48	1·22182	1·22236	1·22291	1·22345	1·22400	1·22455	1·22509	1·22564	1·22619	1·22673
49	1·22728	1·22783	1·22838	1·22893	1·22948	1·23003	1·23058	1·23113	1·23168	1·23223
50	1·23278	1·23334	1·23389	1·23444	1·23499	1·23555	1·23610	1·23666	1·23721	1·23777

COMPARISON OF DEGREES BRIX AND SPECIFIC GRAVITY.—*Continued.*

	0	1	2	3	4	5	6	7	8	9
51	1·23832	1·23888	1·23943	1·23999	1·24055	1·24111	1·24166	1·24222	1·24278	1·24334
52	1·24390	1·24446	1·24502	1·24558	1·24614	1·24670	1·24726	1·24782	1·24839	1·24895
53	1·24951	1·25008	1·25064	1·25120	1·25177	1·25233	1·25290	1·25347	1·25403	1·25460
54	1·25517	1·25573	1·25630	1·26587	1·25744	1·25801	1·25857	1·25914	1·25971	1·26028
55	1·26086	1·26143	1·26200	1·26257	1·26314	1·26372	1·26427	1·26486	1·26544	1·26601
56	1·26658	1·26716	1·26773	1·26831	1 26889	1·26946	1·27004	1·27062	1·27120	1·27177
57	1·27235	1·27293	1·27351	1·27409	1·27467	1·27525	1·27583	1·27641	1·27669	1·27758
58	1·27816	1·27874	1·27932	1·27991	1·28049	1·28107	1·28166	1·28224	1·28283	1·28342
59	1·28400	1·28459	1·28518	1·28576	1·28635	1·28694	1·28753	1·28812	1·28871	1·28930
60	1·28989	1·29048	1·29107	1·29166	1·29225	1·29284	1·29343	1·29403	1·29462	1·29521
61	1·29581	1·29640	1·29700	1·29759	1·29819	1·29878	1·29938	1·29998	1·30057	1·30117
62	1·30177	1·30237	1·30297	1·30356	1·30461	1·30476	1·39536	1·30596	1·30657	1·30717
63	1·30777	1·80837	1·30897	1·30958	1·31018	1·31078	1·31139	1·31199	1·31260	1·31320
64	1·31381	1·31442	1·31502	1·31563	1·31624	1·31684	1·31745	1·31806	1·31867	1·31928
65	1·31989	1·32050	1·32111	1·32172	1·32233	1·32294	1·32355	1·32417	1·32478	1·32539
66	1·32601	1·32662	1·32724	1·32785	1·32847	1·32908	1·32970	1·33031	1·33093	1·33155
67	1·33217	1·33278	1·33340	1·33402	1·33464	1·33526	1·33588	1·33650	1·33712	1·33774
68	1·33836	1·33899	1·33961	1·34023	1·34085	1·34148	1·34210	1·34273	1·34335	1·34398
69	1·34460	1·34523	1·34585	1·34648	1·34711	1·34774	1·34836	1·34899	1·34962	1·35022
70	1·35088	1·35151	1·35214	1·35277	1·35340	1·35403	1·35466	1·35530	1·35593	1·35656
71	1·35720	1·35783	1·35847	1·35910	1·35974	1·36037	1·36101	1·36164	1·36228	1·36292
72	1·36355	1·36419	1·36483	1·36547	1·36611	1·36677	1·36739	1·36803	1·36867	1·36931
73	1·36995	1·37059	1·37124	1·37188	1·37252	1·37317	1·37381	1·37446	1·37510	1·37575

74	1·37639	1·37704	1·37768	1·37833	1·37898	1·37962	1·38027	1·38092	1·38157	1·38222
75	1·38287	1·38352	1·38417	1·38482	1·38547	1·38612	1·38677	1·38743	1·38808	1·38873
76	1·38939	1·39004	1·39070	1·39135	1·39201	1·39266	1·39332	1·39397	1·39463	1·39529
77	1·39595	1·39660	1·39726	1·39792	1·39858	1·39924	1·39990	1·40056	1·40122	1·40188
78	1·40254	1·40321	1·40387	1·40453	1·40520	1·40586	1·40652	1·40719	1·40785	1·40852
79	1·40918	1·40985	1·41052	1·41118	1·41185	1·41252	1·41318	1·41385	1·41452	1·41519
80	1·41586	1·41653	1·41720	1·41787	1·41854	1·41921	1·41989	1·42056	1·42123	1·42190
81	1·42258	1·42325	1·42393	1·42460	1·42528	1·42595	1·42663	1·42731	1·42798	1·42866
82	1·42934	1·43002	1·43070	1·43137	1·43205	1·43273	1·43341	1·43409	1·43478	1·43546
83	1·43614	1·43682	1·43750	1·43819	1·43887	1·43955	1·44024	1·44092	1·44161	1·44229
84	1·44298	1·44367	1·44435	1·44504	1·44573	1·44641	1·44710	1·44779	1·44841	1·44917
85	1·44986	1·45055	1·45124	1·45193	1·45262	1·45331	1·45401	1·45470	1·45539	1·45609
86	1·45678	1·45748	1·45817	1·45887	1·45956	1·46026	1·46095	1·46165	1·46235	1·46304
87	1·46374	1·46444	1·46514	1·46584	1·46654	1·46724	1·46794	1·46864	1·46934	1·47004
88	1·47074	1·47145	1·47215	1·47285	1·47356	1·47426	1·47496	1·47567	1·47637	1·47708
89	1·47778	1·47849	1·47920	1·47991	1·48061	1·48132	1·48203	1·48874	1·48345	1·48416
90	1·48486	1·48558	1·48629	1·48700	1·48771	1·48842	1·48813	1·48985	1·49056	1·49127
91	1·49199	1·49270	1·49342	1·49413	1·49485	1·49556	1·49628	1·49700	1·49771	1·49843
92	1·49915	1·49987	1·50058	1·50130	1·50202	1·50274	1·50346	1·50419	1·50491	1·50563
93	1·50635	1·50707	1·50779	1·50852	1·50924	1·50996	1·51069	1·51141	1·51214	1·51286
94	1·51359	1·51431	1·51504	1·51577	1·51640	1·51722	1·51795	1·51868	1·51941	1·52014
95	1·52087	1·52159	1·53232	1·52304	1·52376	1·52449	1·52521	1·52593	1·52665	1·52738
96	1·52810	1·52884	1·52958	1·53032	1·53106	1·53180	1·53254	1·53328	1·53402	1·53476
97	1·53550	1·53624	1·53698	1·53772	1·53846	1·53920	1·53994	1·54068	1·54142	1·54216
98	1·54290	1·54365	1·54440	1·54515	1·54590	1·54665	1·54740	1·54815	1·44890	1·54965
99	1·55040	1·55115	1·55189	1·55264	1·55338	1·55413	1·55487	1·55562	1·55636	1·55711
100	1·55785	....	....	....	....	....	....	....	....	....

2. TABLE for finding the Sucrose Content of Juices, clarified with 10% the Readings in a Schmidt & Haensch's

Degrees Brix from 0·5 to 12.		Readings of the Polari-scope.	DEGREES BRIX AND							
Degrees Brix.	% Sucrose.		0·5	1·0	1·5	2·0	2·5	3·0	3·5	4·0
			1·0019	1·0039	1·0058	1·0078	1·0098	1·0117	1·0137	1·0157
0·1°	0·03	1°	0·29	0·29	0·29	0·28	0·28	0·28	0·28	0·28
0·2	0·06	2		0·57	0·57	0·57	0·57	0·56	0·56	0·56
0·3	0·08	3		0·85	0·85	0·85	0·85	0·85	0·85	0·84
0·4	0·11	4			1·14	1·13	1·13	1·13	1·13	1·13
0·5	0·14	5			1·42	1·42	1·41	1·41	1·41	1·41
0·6	0·17	6				1·70	1·70	1·69	1·69	1·69
0·7	0·19	7				1·98	1·98	1·98	1·97	1·97
0·8	0·22	8					2·26	2·26	2·26	2·25
0·9	0·25	9						2·54	2·54	2·53
		10						2·82	2·82	2·81
		11							3·10	3·09
		12							3·38	3·38
		13								3 66
		14								3·94
		15								
		16								
		17								
		11								
		19								
		20								
		21								
		22								
		23								
		24								
		25								
		26								
		27								
		28								
		29								
		30								
		31								
		32								
		33								
		34								
		35								
		36								
		37								
		38								
		39								

of Subacetate of Lead from the Specific Gravity of the original Juice, and Polariscope, when observed in a 200 mm. Tube.

Corresponding Specific Gravity.											
4·5	5·0	5·5	6·0	6·5	7·0	7·5	8·0	8·5	9·0	9·5	10·0
1·0177	1·0197	1·0217	1·0237	1·0258	1·0278	1·0298	1·0319	1·0339	1·0360	1·0381	1·0401
0·28	0·28	0·28	0·28	0·28	0·28	0·28	0·28	0·28	0·28	0·28	0·28
0·56	0·56	0·56	0·56	0·56	0·56	0·55	0·55	0·55	0·55	0·55	0·55
0·84	0·84	0·84	0·84	0·84	0·83	0·83	0·83	0·83	0·83	0·83	0·82
1·12	1·12	1·12	1·12	1·11	1·11	1·11	1·11	1·11	1·10	1·10	1·10
1·40	1·40	1·40	1·40	1·39	1·39	1·39	1·38	1·38	1·38	1·38	1·37
1·68	1·68	1·68	1·67	1·67	1·67	1·66	1·66	1·66	1·66	1·65	1·65
1·96	1·96	1·96	1·95	1·95	1·95	1·94	1·94	1·93	1·93	1·93	1·92
2·25	2·24	2·24	2·23	2·23	2·22	2·22	2·22	2·21	2·21	2·20	2·20
2·53	2·52	2·52	2·51	2·51	2·50	2·50	2·49	2·49	2·48	2·48	2·47
2·81	2·80	2·80	2·79	2·79	2·78	2·78	2·77	2·76	2·76	2·75	2·75
3·09	3·08	3·08	3·07	3·06	3·06	3·05	3·05	3·04	3·03	3·03	3·02
3·37	3·36	3·36	3·35	3·34	3·34	3·33	3·32	3·32	3·31	3·30	3·30
3·65	3·64	3·64	3·63	3·62	3·61	3·61	3·60	3·59	3·59	3·58	3·57
3·93	3·92	3·92	3·91	3·90	3·89	3·88	3·88	3·87	3·86	3·85	3·85
4·21	4·20	4·19	4·19	4·18	4·17	4·16	4·15	4·15	4·14	4·13	4·12
4·49	4·48	4·47	4·47	4·46	4·45	4·44	4·43	4·42	4·41	4·40	4·40
	4·77	4·76	4·75	4·74	4·73	4·72	4·71	4·70	4·69	4·68	4·67
		5·03	5·02	5·01	5·00	4·99	4·99	4·97	4·97	4·96	4·95
		5·32	5·31	5·29	5·28	5·27	5·26	5·25	5·24	5·23	5·22
			5·58	5·57	5·56	5·55	5·54	5·53	5·52	5·51	5·50
			5·86	5·85	5·84	5·83	5·82	5·81	5·79	5·78	5·77
				6·13	6·12	6·11	6·09	6·08	6·07	6·06	6·05
				6·41	6·40	6·38	6·37	6·36	6·35	6·33	6·32
					6·67	6·66	6·65	6·64	6·62	6·61	6·60
						6·94	6·93	6·91	6·90	6·89	6·87
						7·22	7·20	7·19	7·17	7·16	7·15
							7·48	7·46	7·45	7·44	7·42
							7·76	7·74	7·73	7·71	7·70
								8·02	8·00	7·99	7·97
									8·28	8·26	8·25
									8·55	8·54	8·52
									8·83	8·81	8·80
										9·09	9·07
											9·35
											9·62

TABLE 2.—(*Continued.*)

Readings of the Polariscope.	DEGREES BRIX AND										
	10·5	11·0	11·5	12·0	12·5	13·0	13·5	14·0	14·5	15·0	15·5
	1·0422	1·0443	1·0464	1·0485	1·0506	1·0528	1·0549	1·0570	1·0592	1·0613	1·0635
1°	0·28	0·27	0·27	0·27	0·27	0·27	0·27	0·27	0·27	0·27	0·27
2	0·55	0·55	0·55	0·55	0·54	0·54	0·54	0·54	0·54	0·54	0·54
3	0·82	0·82	0·82	0·82	0·82	0·81	0·81	0·81	0·81	0·81	0·81
4	1·10	1·10	1·09	1·09	1·09	1·09	1·09	1·08	1·08	1·08	1·08
5	1·37	1·37	1·36	1·36	1·36	1·36	1·35	1·35	1·35	1·35	1·34
6	1·64	1·64	1·64	1·64	1·63	1·63	1·62	1·62	1·62	1·62	1·61
7	1·92	1·91	1·91	1·91	1·90	1·90	1·89	1·89	1·89	1·88	1·88
8	2·19	2·19	2·18	2·18	2·13	2·17	2·17	2·16	2·16	2·15	2·15
9	2·47	2·46	2·46	2·45	2·45	2·44	2·44	2·43	2·43	2·42	2·42
10	2·74	2·74	2·73	2·73	2·72	2·71	2·71	2·70	2·70	2·69	2·69
11	3·02	3·01	3·00	3·00	2·99	2·99	2·98	2·97	2·97	2·96	2·95
12	3·29	3·28	3·28	3 27	3·26	3·26	3·25	3·24	3·24	3·23	3·22
13	3·56	3·56	3·55	3·54	3·54	3·53	3·52	3·51	3·51	3·50	3·49
14	3·84	3·83	3·82	3·82	3·81	3·80	3·79	3·78	3·78	3·77	3·76
15	4·11	4·11	4·10	4·09	4·08	4·07	4·06	4·06	4·05	4·04	4·03
16	4·39	4·38	4·37	4·36	4·35	4·34	4·33	4·33	4·32	4·31	4·30
17	4·66	4·65	4·64	4·63	4·62	4·62	4·61	4·60	4·59	4·58	4·57
18	4·93	4·93	4·91	4·91	4·90	4·89	4·88	4·87	4·86	4·85	4·84
19	5·21	5·20	5·19	5·18	5·17	5·16	5·15	5·14	5·13	5·12	5·11
20	5·49	5·47	5·46	5·45	5·44	5·43	5·42	5·41	5·40	5·39	5·38
21	5·76	5·75	5·74	5·73	5·71	5·70	5 69	5·68	5·67	5·66	5·65
22	6·03	6·02	6·01	6·00	5·99	5·97	4·96	5·95	5·94	5·93	5·91
23	6·31	6·30	6·28	6·27	6·26	6·24	6·23	6·22	6·21	6·20	6·18
24	6·58	6·57	6·56	6·54	6·53	6·52	6·50	6·49	6·48	6·46	6·45
25	6·86	6·84	6·83	6·82	6·80	6·79	6·78	6·76	6·75	6·73	6·72
26	7·13	7·12	7·10	7·09	7·07	7·06	7·05	7·03	7·02	7·00	6·99
27	7·41	7·39	7·38	7·36	7·35	7·33	7·32	7·30	7·29	7·27	7·26
28	7·68	7·66	7·65	7·63	7·62	7·60	7·59	7·57	7·56	7·54	7·53
29	7·96	7·94	7·92	7·91	7·89	7·87	7·86	7·84	7·83	7·81	7·80
30	8·23	8·21	8·20	8·18	8·16	8·15	8·13	8·11	8·10	8·08	8·06
31	8·50	8·49	8·47	8·45	8·44	8·42	8·40	8·39	8·37	8·35	8·33
32	8·78	8·76	8·74	8·73	8·71	8·69	8·67	8·66	8·64	8·62	8·60
33	9·05	9·03	9·02	9·00	8·98	8·96	9·94	8·93	8·91	8·89	8·87
34	9·33	9·31	9·29	9·27	8·25	8·23	9·22	9·20	9·18	9·16	9·14
35	9·60	9·58	9·57	9·54	9·53	9·51	9·49	9·47	9·45	9·43	9·41
36	9·88	9·86	9·84	9·82	9·80	9·78	9·76	9·74	9·72	9·70	9·68
37	10·15	10·13	10·11	10·09	10·07	10·05	10·03	10·01	9·99	9·97	9·95
38		10·40	10·38	10·36	10·34	10·32	10·30	10·28	10·26	10·24	10·22
39		10·68	10·66	10·64	10·61	10·59	10·57	10·55	10·53	10·51	10·49

TABLE 2.—(*Continued.*)

Corresponding Specific Gravity.									Readings of the Polari-scope.	Degrees Brix from 10 to 20.	
16·0	16·5	17·0	17·5	18·0	18·5	19·0	19·5	20·0		Degrees Brix.	% Sucrose.
1·0657	1·0678	1·0700	1·0722	1·0744	1·0766	1·0768	1·0811	1·0833			
0·27	0·27	0·27	0·27	0·27	0·27	0·27	0·27	0·26	1°	0·1°	0·03
0·54	0·54	0·53	0·53	0·53	0·53	0·53	0·53	0·53	2	0·2	0·05
0·80	0·80	0·80	0·80	0·80	0·80	0·79	0·79	0·79	3	0·3	0·08
1·07	1·07	1·07	1·07	1·06	1·06	1·06	1·06	1·06	4	0·4	0·11
1·34	1·34	1·34	1·33	1·33	1·33	1·32	1·32	1·32	5	0·5	0·13
1·61	1·61	1·60	1·60	1·60	1·59	1·59	1·59	1·58	6	0·7	0·16
1·88	1·87	1·87	1·86	1·86	1·86	1·85	1·85	1·85	7	0·7	0·19
2·15	2·14	2·14	2·13	2·13	2·12	2·12	2·12	2·11	8	0.8	0·21
2·41	2·41	2·40	2·40	2·39	2·39	2·38	2·38	2·37	9	0·9	0·24
2·68	2·68	2·67	2·67	2·66	2·65	2·65	2·64	2·64	10		
2·95	2·94	2·94	2·93	2·92	2·92	2·91	2·91	2·90	11		
3·22	3·21	3·20	3·20	3·19	3·18	3·18	3·17	3·17	12		
3·49	3·48	3·47	3·46	3·46	3·45	3·44	3·44	3·43	13		
3·75	3·75	3·74	3·73	3·72	3·72	3·71	3·70	3·69	14		
4·02	4·02	4·01	4·00	3·99	3·98	3·97	3·97	3·96	15		
4·29	4·28	4·27	4·26	4·26	4·25	4·24	4·23	4·22	16		
4·56	4·55	4·54	4·53	4·52	4·51	4·50	4·49	4·48	17		
4·83	4·82	4·81	4·80	4·79	4·78	4·77	4·76	4·75	18		
5·10	5·09	5·08	5·06	5·05	5·04	5·03	5·02	5·01	19		
5·36	5·35	5·34	5·33	5·32	5·31	5·30	5·29	5·28	20		
5·63	5·62	5·61	5·60	5·59	5·58	5·56	5·55	5·54	21		
5·90	5·89	5·88	5·87	5·85	5·84	5·83	5·82	5·80	22		
6·17	6·16	6·14	6·13	6·12	6·11	6·09	6·08	6·07	23		
6·44	6·43	6·41	6·40	6·39	6·37	6·36	6·35	6·33	24		
6·71	6·69	6·68	6·67	6·65	6·64	6·63	6·61	6·60	25		
6·97	6·96	6·95	6·93	6·92	6·90	6·89	6·88	6·86	26		
7·24	7·23	7·21	7·20	7·18	7·17	7·15	7·14	7·13	27		
7·51	7·50	7·48	7·47	7·45	7·44	7·42	7·40	7·39	28		
7·78	7·77	7·75	7·73	7·72	7·70	7·68	7·67	7·65	29		
8·05	8·03	8·02	8·00	7·98	7·97	7·95	7·93	7·92	30		
8·32	8·30	8·28	8·27	8·25	8·23	8·21	8·20	8·18	31		
8·58	8·57	8·55	8·53	8·51	8·50	8·48	8·46	8·45	32		
8·85	8·84	8·82	8·80	8·78	8·76	8·75	8·73	8·71	33		
9·12	9·10	9·09	9·07	9·05	9·03	9·01	8·99	8·97	34		
9·39	9·37	9·35	9·34	9·31	9·30	9·28	9·26	9·24	35		
9·66	9·64	9·62	9·60	9·58	9·56	9·54	9·52	9·50	36		
9·93	9·91	9·89	9·87	9·85	9·83	9·81	9·79	9·77	37		
10·20	10·18	10·15	10·13	10·11	10·09	10·07	10·05	10·03	38		
10·46	10·44	10·42	10·40	10·38	10·36	10·34	10·32	10·29	39		

TABLE 2.—(*Continued.*)

Degrees Brix from 11·5 to 17·5.		Readings of the Polariscope.	DEGREES BRIX AND				
			11·5	12·0	12·5	13·0	13·5
Degrees Brix.	% Sucrose.		1·0464	1·0485	1·0506	1·0528	1·0549
0·1°	0·03	40°	10·93	10·91	10·89	10·86	10·84
0·2	0·05	41		11·18	11·16	11·14	11·12
0·3	0·08	42		11·46	11·43	11·41	11·39
0·4	0·11	43			11·71	11·68	11·66
0·5	0·13	44			11·98	11·95	11·93
0·6	0·16	45			12·25	12·23	12·20
0·7	0·19	46				12·50	12·47
0·8	0·21	47					12·74
0·9	0·24	48					13·02
		49					
		50					
		51					
		52					
		53					
		54					
		55					
		56					
		57					
		58					
		59					
		60					
		61					
		62					
		63					
		64					
		65					
		66					
		67					
		68					
		69					
		70					
		71					
		72					
		73					
		74					
		75					
		76					
		77					
		78					
		79					
		80					

TABLE 2.—(*Continued.*)

CORRESPONDING SPECIFIC GRAVITY.

14·0	14·5	15·0	15·5	16·0	16·5	17·0	17·5
1·0570	1·0592	1·0613	1·0635	1·0657	1·0678	1·0700	1·0722
10·82	10·80	10·78	10·76	10·73	10·71	10·69	10·67
11·09	11·07	11·05	11·03	11·00	10·98	10·96	10·94
11·36	11·34	11·32	11·29	11·27	11·25	11·23	11·20
11 64	11·61	11·59	11·56	11·54	11·52	11·49	11·47
11·91	11·88	11·86	11·83	11·81	11·79	11·76	11·74
12·18	12·15	12·13	12·10	12·08	12·05	12·03	12·01
12·45	12·42	12·40	12·37	12·35	12·32	12·30	12·27
12·72	12·69	12·67	12·64	12·61	12·59	12·56	12·54
12·99	12·97	12·94	12·91	12·88	12·86	12·83	12·81
13·26	13·23	13·21	13·18	13·15	13·13	13·10	13·07
	13·50	13·48	13·45	13·42	13·40	13·37	13·34
	13·78	13·75	13·72	13·69	13·66	13·64	13·61
		14·02	13·99	13·96	13·93	13·90	13·88
		14·29	14·26	14·23	14·20	14·17	14·14
			14·53	14·50	14·47	14·44	14·41
			14·80	14·77	14·74	14·71	14·68
				15·03	15·00	14·97	14·94
				15·30	15·27	15·24	15·21
				15·57	15·54	15·51	15·48
					15·81	15·78	15·75
						16·05	16·01
						16·31	16·28
							16·55
							16·82

TABLE 2.—(*Continued.*)

Readings of the Polariscope.	DEGREES BRIX AND						
	18·0	18·5	19·0	19·5	20·0	20·5	21·0
	1·0744	1·0766	1·0788	1·0811	1·0833	1·0855	1·0878
40°	10·64	10·62	10·60	10·58	10·56	10·54	10·52
41	10·91	10·89	10·87	10·85	10·82	10·80	10·78
42	11·18	11·16	11·13	11·11	11·09	11·07	11·04
43	11·45	11·42	11·40	11·38	11·35	11·33	11·31
44	11·71	11·69	11·66	11·64	11·62	11·59	11·57
45	11·98	11·96	11·93	11·91	11·88	11·86	11·83
46	12·25	12·22	12·20	12·17	12·15	12·12	12·09
47	12·51	12·49	12·46	12·44	12·41	12·39	12·36
48	12·78	12·75	12·73	12·70	12·67	12·65	12·62
49	13·05	13·02	12·99	12·97	12·94	12·91	12·88
50	13·31	13·29	13·26	13·23	13·20	13·18	13·15
51	13·58	13·55	13·52	13·50	13·47	13·44	13·41
52	13·85	13·82	13·79	13·76	13·73	13·70	13·68
53	14·11	14·08	14·05	14·03	14·00	13·97	13·94
54	14·38	14·35	14·32	14·29	14·26	14·23	14·20
55	14·65	14·62	14·59	14·56	14·53	14·50	14·47
56	14·91	14·88	14·85	14·82	14·79	14·76	14·73
57	15·18	15·15	15·12	15·09	15·06	15·02	14·99
58	15·45	15·42	15·38	15·35	15·32	15·29	15·26
59	15·71	15·68	15·65	15·62	15·58	15·55	15·52
60	15·98	15·95	15·92	15·88	15·85	15·82	15·78
61	16·25	16·21	16·18	16·15	16·11	16·08	16·05
62	16·52	16·48	16·45	16·41	16·38	16·35	16·31
63	16·78	16·75	16·71	16·68	16·64	16·61	16·57
64	17·05	17·01	16·98	16·94	16·91	16·87	16·84
65	17·32	17·29	17·24	17·21	17·17	17·14	17·10
66		17·55	17·51	17·47	17·44	17·40	17·37
67		17·81	17·78	17·74	17·70	17·67	17·63
68			18·04	18·00	17·97	17·93	17·89
69			18·31	18·27	18·23	18·19	18·16
70				18·53	18·50	18·46	18·42
71					18·76	18·72	18·68
72					19·03	18·99	18·95
73						19·25	19·21
74						19·52	19·48
75						19·78	19·74
76							20·00
77							20·27
78							
79							
80							

TABLE 2.—(*Continued.*)

Corresponding Specific Gravity.						Readings of the Polari-scope.	Degrees Brix from 18 to 24.	
21·5	22·0	22·5	23·0	23·5	24·0		Degrees Brix.	% Sucrose.
1·0900	1·0923	1·0946	1·0969	1·0992	1·1015			
10·49	10·47	10·45	10·43	10·41	10·38	40°		
10·76	10·74	10·71	10·69	10·67	10·65	41	0·1°	0·03
11·02	11·00	10·97	10·95	10·93	10·90	42	0·2	0·05
11·28	11·26	11·24	11·21	11·19	11·17	43	0·3	0·08
11·55	11·52	11·50	11·47	11·45	11·42	44	0·4	0·10
11·81	11·78	11·76	11·73	11·71	11·69	45	0·5	0·13
12·07	12·05	12·02	12·00	11·97	11·94	46	0·6	0·16
12·33	12·31	12·28	12·26	12·23	12·21	47	0·7	0·18
12·60	12·57	12·54	12·52	12·49	12·47	48	0·8	0·21
12·86	12·83	12·81	12·78	12·75	12·73	49	0·9	0·23
13·12	13·09	13·07	13·04	13·01	12·99	50		
13·39	13·36	13·33	13·30	13·27	13·25	51		
13·65	13·62	13·59	13·56	13·53	13·51	52		
13·91	13·88	13·85	13·82	13·79	13·77	53		
14·17	14·14	14·11	14·08	14·06	14·02	54		
14·44	14·41	14·38	14·35	14·32	14·29	55		
14·70	14·67	14·64	14·61	14·58	14·55	56		
14·96	14·93	14·90	14·87	14·84	14·81	57		
15·23	15·19	15·16	15·13	15·10	15·07	58		
15·49	15·46	15·42	15·39	15·36	15·33	59		
15·75	15·72	15·69	15·65	15·62	15·59	60		
16·01	15·98	15·95	15·91	15·88	15·85	61		
16·28	16·24	16·21	16·18	16·14	16·11	62		
16·54	16·51	16·47	16·44	16·40	16·37	63		
16·80	16·77	16·73	16·70	16·66	16·63	64		
17·07	17·03	17·00	16·96	16·92	16·89	65		
17·33	17·29	17·26	17·22	17·19	17·15	66		
17·59	17·56	17·52	17·48	17·45	17·41	67		
17·86	17·82	17·78	17·74	17·71	17·67	68		
18·12	18·08	18·04	18·00	17·97	17·93	69		
18·38	18·35	18·31	18·27	18·23	18·19	70		
18 65	18·61	18·57	18·53	18·49	18·45	71		
18·91	18·87	18·83	18·79	18·75	18·71	72		
19·17	19·13	19·09	19·05	19·01	18·97	73		
19·44	19 40	19·35	19·31	19·27	19·23	74		
19·70	19·66	19·62	19·57	19·53	19·49	75		
19·96	19·92	19·88	19·84	19·80	19·75	76		
20·22	20·18	20·14	20·10	20·06	20·01	77		
20·49	20·45	20·40	20·36	20·32	20·27	78		
20·75	20·71	20·66	20·62	20·58	20·54	79		
	20·97	20·93	20·88	20·84	20·80	80		

3. Table showing the Sucrose Content of Bagasse from Polarised in the 400 mm. Tube.

Grammes liquid.	2·0	2·1	2·2	2·3	2·4	2·5	2·6	2·7	2·8	2·9
200	2·59	2·72	2·85	2·98	3·11	3·24	3·37	3·50	3·65	3·76
205	2·66	2·80	2·92	3·05	3·19	3·32	3·46	3·59	3·72	3·85
210	2·72	2·87	3·00	3·13	3·27	3·40	3·54	3·68	3·81	3·95
215	2·79	2·93	3·07	3·20	3·34	3·48	3·62	3·76	3·90	4·04
220	2·85	3·00	3·14	3·28	3·42	3·56	3·70	3·85	4·00	4·14
225	2·91	3·07	3·21	3·36	3·50	3·65	3·80	3·94	4·09	4·23
230	2·99	3·14	3·28	3·42	3·58	3·72	3·88	4·02	4·18	4·33
235	3·05	3·20	3·36	3·50	3·67	3·81	3·97	4·11	4·27	4·42
240	3·11	3·26	3·43	3·58	3·73	3·90	4·06	4·20	4·36	4·51
245	3·18	3·34	3·50	3·65	3·81	3·97	4·13	4·29	4·45	4·60
250	3·24	3·40	3·57	3·73	3·90	4·06	4·21	4·38	4·55	4·70
255	3·31	3·48	3·64	3·80	3·98	4·14	4·30	4·48	4·64	4·80
260	3·38	3·55	3·71	3·88	4·05	4·22	4·39	4·57	4·73	4·90
265	3·44	3·61	3·79	3·96	4·13	4·31	4·47	4·66	4·82	4·99
270	3·51	3·68	3·86	4·03	4·20	4·39	4·55	4·75	4·91	5·08
275	3·58	3·75	3·93	4·10	4·29	4·47	4·63	4·84	5·00	5·18
280	3·64	3·82	4·00	4·18	4·36	4·55	4·72	4·93	5·10	5·27
285	3·70	3·89	4·08	4·26	4·44	4·63	4·80	5·02	5·19	5·37
290	3·78	3·96	4·15	4·33	4·52	4·71	4·89	5·11	5·28	5·46
295	3·84	4·02	4·22	4·41	4·60	4·79	4·97	5·20	5·37	5·55
300	3·90	4·10	4·29	4·48	4·68	4·87	5·06	5·30	5·46	5·65

This table is calculated for 20 grammes

the polariscopical Reading and the Grammes of Liquid;

$$Sb = \text{Polarisation} \times \frac{26{\cdot}048}{20} \times \frac{\text{Gr.}}{100} \times \frac{1}{2}$$

3·0	3·1	3·2	3·3	3·4	3·5	3·6	3·7	3·8	3·9	4·0
3·90	4·02	4·15	4·28	4·41	4·54	4·68	4·80	4·95	5·08	5·21
3·99	4·12	4·26	4·39	4·52	4·66	4·80	4·92	5·07	5·20	5·34
4·09	4·22	4·36	4·50	4·64	4·78	4·91	5·04	5·19	5·33	5·46
4·19	4·32	4·47	4·60	4·75	4·89	5·04	5·16	5·32	5·46	5·60
4·29	4·42	4·57	4·71	4·86	5·00	5·15	5·28	5·44	5·58	5·73
4·38	4·52	4·67	4·81	4·97	5·11	5·27	5·40	5·56	5·71	5·86
4·48	4·62	4·78	4·92	5·08	5·23	5·39	5·53	5·69	5·84	6·00
4·59	4·72	5·89	5·03	5·20	5·34	5·51	5·64	5·81	5·96	6·12
4·68	4·83	5·00	5·14	5·30	5·45	5·61	5·77	5·94	6·09	6·25
4·78	4·93	5·09	5·24	5·40	5·56	5·72	5·88	6·06	6·22	6·33
4·88	5·03	5·19	5·35	5·51	5·68	5·84	6·00	6·18	6·34	6·51
4·98	5·13	5·29	5·46	5·62	5·79	5·96	6·14	6·31	6·47	6·64
5·07	5·23	5·40	5·57	5·73	5·90	6·08	6·26	6·43	6·60	6·77
5·17	5·33	5·50	5·67	5·85	6·02	6·20	6·37	6·55	6·73	6·90
5·27	5·43	5·60	5·78	6·06	6·13	6·30	6·49	6·68	6·85	7·03
5·37	5·53	5·70	5·89	6·07	6·25	6·42	6·60	6·80	6·98	7·16
5·46	5·64	5·81	6·00	6·18	6·36	6·45	6·73	6·92	7·11	7·29
5·56	5·74	5·91	6·10	6·29	6·48	6·66	6·84	7·05	7·23	7·42
5·66	5·84	6·02	6·21	6·40	6·59	6·78	6·97	7·17	7·36	7·55
5·76	5·94	6·12	6·32	6·50	6·70	6·90	7·10	7·30	7·49	7·68
5·86	6·04	6·23	6·43	6·62	6·81	7·01	7·20	7·42	7·61	7·81

of bagasse and ± 300 c.cm. of water.

4. COMPARISON OF CENTIGRADE AND FAHRENHEIT SCALES.

Centigrade.	Fahrenheit.	Centigrade.	Fahrenheit.	Centigrade.	Fahrenheit.	Centigrade.	Fahrenheit.
0	32·	26	78·8	51	123·8	76	168·8
1	33·8	27	80·6	52	125·6	77	170·6
2	35·6	28	82·4	53	127·4	78	172·4
3	37·4	29	84·2	54	129·2	79	174·2
4	39·2	30	86·	55	131·	80	176·
5	41·	31	87·8	56	132·8	81	177·8
6	42·8	32	89·6	57	134·6	82	179·6
7	44·6	33	91·4	58	136·4	83	181·4
8	46·4	34	93·2	59	138·2	84	183·2
9	48·2	35	95·	60	140·	85	185·
10	50·	36	96·8	61	141·8	86	186·8
11	51·8	37	98·6	62	143·6	87	188·6
12	53·6	38	100·4	63	145·4	88	190·4
13	55·4	39	102·2	64	147·2	89	192·2
14	57·2	40	104·	65	149·	90	194·
15	59·	41	105·8	56	150·8	91	195·8
16	60·8	42	107·6	67	152·6	92	197·6
17	62·6	43	109·4	68	154·4	93	199·4
18	64·4	44	111·2	69	156·2	94	201·2
19	66·2	45	113·	70	158·0	95	203·
20	68·	46	114·8	71	159·8	96	204·8
21	69·8	47	116·6	72	161·6	97	206·6
22	71·6	48	118·4	73	163·4	98	208·4
23	73·4	49	120·2	74	165·2	99	210·2
24	75·2	50	122·	75	167·	100	212·
25	77·						

5. Table for the Corrections of the Brix Hydrometer for Different Temperatures.

The Hydrometer is tested at 17·5° c.

Temperature of the Juice.	Degrees Brix.									
	0	5	10	15	20	25	30	35	40	50
	Subtract from the Readings.									
15° Cels.	0·09	0·11	0·12	0·14	0·14	0·15	0·16	0·17	0·17	0·17
16 ,,	0·06	0·07	0·08	0·09	0·10	0·10	0·11	0·12	0·12	0·12
17 ,,	0·02	0·02	0·03	0·03	0·03	0·04	0·04	0·04	0·04	0·04
	Add to the Readings.									
18 ,,	0·02	0·03	0·03	0·03	0·03	0·03	0·03	0·03	0·03	0·03
19 ,,	0·06	0·08	0·08	0·09	0·09	0·10	0·10	0·10	0·10	0·10
20 ,,	0·11	0·14	0·15	0·17	0·17	0·18	0·18	0·18	0·19	0·19
21 ,,	0·16	0·20	0·22	0·24	0·24	0·25	0·25	0·25	0·26	0·26
22 ,,	0·21	0·26	0·29	0·31	0·31	0·32	0·32	0·32	0·33	0·34
23 ,,	0·27	0·32	0·35	0·37	0·38	0·39	0·39	0·39	0·40	0·42
24 ,,	0·32	0·38	0·41	0·43	0·44	0·46	0·46	0·47	0·47	0·50
25 ,,	0·37	0·44	0·47	0·49	0·51	0·53	0·54	0·55	0·55	0·58
26 ,,	0·43	0·50	0·54	0·56	0·58	0·60	0·61	0·61	0·62	0·66
27 ,,	0·49	0·57	0·61	0·63	0·65	0·68	0·68	0·69	0·70	0·74
28 ,,	0·56	0·64	0·68	0·70	0·72	0·76	0·76	0·78	0·78	0·82
29 ,,	0·63	0·71	0·75	0·78	0·79	0·84	0·84	0·86	0·86	0·90
30 ,,	0·70	0·78	0·82	0·87	0·87	0·92	0·92	0·94	0·94	0·98
31 ,,	0·78	0·85	0·90	0·94	0·95	1·00	1·00	1·02	1·02	1·06
32 ,,	0·86	0·93	0·98	1·01	1·03	1·08	1·08	1·10	1·10	1·14
33 ,,	0·94	1·01	1·06	1·08	1·12	1·16	1·16	1·18	1·18	1·22
34 ,,	1·02	1·09	1·14	1·16	1·21	1·24	1·24	1·26	1·27	1·30
35 ,,	1·10	1·17	1·22	1·24	1·30	1·32	1·33	1·35	1·36	1·39

6. Table for the Corrections of the Brix Hydrometer for Different Temperatures.

The Hydrometer is tested at 27·5° C.

Temperature of the Juice.	Degrees Brix.									
	0	5	10	15	20	25	30	35	40	50
	Subtract from the Readings.									
15° Cels.	0·61	0·71	0·75	0·80	0·82	0·87	0·88	0·91	0·91	0·95
16 ,,	0·58	0·67	0·71	0·75	0·78	0·82	0·83	0·86	0·87	0·90
17 ,,	0·54	0·62	0·66	0·69	0·71	0·76	0·76	0·78	0·79	0·82
18 ,,	0·50	0·57	0·60	0·63	0·65	0·69	0·69	0·70	0·71	0·75
19 ,,	0·46	0·52	0·55	0·57	0·59	0·62	0·62	0·63	0·64	0·68
20 ,,	0·41	0·46	0·48	0·49	0·51	0·54	0·54	0·55	0·56	0·59
21 ,,	0·36	0·40	0·41	0·42	0·44	0·47	0·47	0·48	0·48	0·52
22 ,,	0·31	0·34	0·34	0·35	0·37	0·40	0·40	0·41	0·41	0·44
23 ,,	0·25	0·28	0·28	0·29	0·30	0·33	0·33	0·34	0·34	0·36
24 ,,	0·20	0·22	0·22	0·23	0·23	0·26	0·26	0·26	0·26	0·28
25 ,,	0·15	0·16	0·16	0·17	0·17	0·19	0·19	0·19	0·19	0·20
26 ,,	0·09	0·10	0·10	0·10	0·10	0·12	0·12	0·12	0·12	0·12
27 ,,	0·03	0·03	0·03	0·03	0·03	0·04	0·04	0·04	0·04	0·04
	Add to the Readings.									
28° Cels.	0·04	0·04	0·04	0·04	0·04	0·04	0·04	0·04	0·04	0·04
29 ,,	0·11	0·11	0·11	0·11	0·11	0·12	0·12	0·12	0·12	0·12
30 ,,	0·18	0·19	0·19	0·19	0·19	0·20	0·20	0·20	0·20	0·20
31 ,,	0·26	0·27	0·27	0·28	0·28	0·28	0·28	0·28	0·28	0·28
32 ,,	0·34	0·35	0·35	0·35	0·35	0·36	0·36	0·36	0·36	0·36
33 ,,	0·42	0·42	0·42	0·42	0·43	0·44	0·44	0·44	0·44	0·44
34 ,,	0·50	0·50	0·50	0·50	0·51	0·52	0·52	0·52	0·52	0·52
35 ,,	0·58	0·58	0·59	0·59	0·60	0·60	0·61	0·61	0·61	0·61

7. Table showing the Percentage of Glucose in Juices, Diluted Syrups, Masse-cuites, and Molasses from the number of c.cm. of Prepared Solution and the Degrees Brix of the Original Liquid.

The liquid used for the polarisation is diluted five times and tested with 10 c.cm. of half normal Fehling's test solution (= 25 mgr. of glucose).

CUBIC CENTIMETRES.

Degrees Brix.	10·0	10·2	10·4	10·6	10·8	11·0	11·2	11·4	11·6	11·8	12·0	12·2	12·4	12·6	13·1	13·3	13·6	13·8	14·1	14·4	14·7	15·1	15·4	15·7	16·1	16·5	16·9	17·5	18·0	18·5	19·0	19·6	20·1
10	1·32	1·30	1·27	1·25	1·22	1·20	1·18	1·16	1·14	1·12	1·10	1·08	1·07	1·06	1·02	0·99	0·97	0·96	0·94	0·92	0·90	0·88	0·86	0·84	0·82	0·80	0·78	0·75	0·73	0·71	0·70	0·67	0·66
11	1·32	1·29	1·27	1·24	1·22	1·20	1·18	1·15	1·14	1·12	1·10	1·08	1·06	1·04	1·01	0·99	0·97	0·95	0·93	0·91	0·90	0·87	0·85	0·84	0·82	0·80	0·78	0·75	0·73	0·71	0·69	0·67	0·66
12	1·31	1·29	1·26	1·24	1·21	1·19	1·17	1·15	1·13	1·11	1·09	1·07	1·06	1·04	1·01	0·99	0·96	0·95	0·93	0·91	0·89	0·87	0·85	0·84	0·81	0·79	0·78	0·75	0·73	0·71	0·69	0·67	0·65
13	1·31	1·28	1·26	1·23	1·21	1·19	1·17	1·15	1·13	1·11	1·09	1·07	1·05	1·04	1·00	0·98	0·96	0·95	0·93	0·91	0·89	0·86	0·85	0·83	0·81	0·79	0·77	0·74	0·73	0·71	0·69	0·67	0·65
14	1·30	1·28	1·25	1·23	1·20	1·18	1·16	1·14	1·12	1·10	1·08	1·07	1·05	1·03	1·00	0·98	0·96	0·94	0·92	0·90	0·88	0·86	0·84	0·83	0·81	0·79	0·77	0·74	0·72	0·70	0·68	0·66	0·65
15	1·30	1·27	1·25	1·22	1·20	1·18	1·16	1·14	1·12	1·10	1·08	1·06	1·04	1·03	1·00	0·97	0·95	0·94	0·92	0·90	0·88	0·86	0·84	0·83	0·80	0·79	0·77	0·74	0·72	0·70	0·68	0·66	0·64
16	1·29	1·26	1·24	1·22	1·19	1·17	1·15	1·13	1·11	1·09	1·08	1·06	1·04	1·02	0·99	0·97	0·95	0·93	0·92	0·90	0·88	0·85	0·84	0·82	0·80	0·78	0·76	0·73	0·72	0·70	0·68	0·66	0·64
17	1·29	1·26	1·24	1·21	1·19	1·17	1·15	1·13	1·11	1·09	1·07	1·05	1·04	1·02	0·99	0·97	0·94	0·93	0·91	0·89	0·87	0·85	0·83	0·82	0·80	0·78	0·76	0·73	0·71	0·69	0·68	0·66	0·64
18	1·28	1·25	1·23	1·21	1·19	1·16	1·14	1·12	1·10	1·08	1·07	1·05	1·03	1·02	0·98	0·96	0·94	0·93	0·91	0·89	0·87	0·85	0·83	0·82	0·79	0·78	0·76	0·73	0·71	0·69	0·67	0·65	0·64
19	1·27	1·25	1·23	1·20	1·18	1·16	1·14	1·12	1·10	1·08	1·06	1·04	1·03	1·01	0·98	0·96	0·94	0·92	0·90	0·89	0·87	0·84	0·83	0·81	0·79	0·77	0·75	0·72	0·71	0·69	0·67	0·65	0·63
20	1·27	1·24	1·22	1·20	1·18	1·15	1·13	1·11	1·09	1·08	1·06	1·04	1·02	1·01	0·98	0·95	0·93	0·92	0·90	0·88	0·86	0·84	0·82	0·81	0·79	0·77	0·75	0·72	0·71	0·69	0·67	0·65	0·63
21	1·26	1·24	1·22	1·19	1·17	1·15	1·13	1·11	1·09	1·07	1·05	1·04	1·02	1·00	0·97	0·95	0·93	0·92	0·90	0·88	0·86	0·84	0·82	0·81	0·79	0·77	0·75	0·72	0·70	0·68	0·67	0·64	0·63
22	1·26	1·23	1·21	1·19	1·17	1·14	1·12	1·10	1·09	1·07	1·05	1·03	1·02	1·00	0·97	0·95	0·93	0·91	0·89	0·87	0·86	0·83	0·82	0·80	0·78	0·76	0·74	0·72	0·70	0·68	0·66	0·64	0·63

If less than 10 c.cm. are already sufficient to decolorize the test solution, the liquid used for the polarisation is to be diluted ten times, and the figure yielded by the table to be multiplied by 2.

$$\text{Formula: } x = \frac{110 \times 5 \times 0{\cdot}025}{a \times \text{sp. gravity.}}.$$

8. Table showing the Glucose Content of Commercial Sugar when 26·048 grammes are dissolved in 100 c.cm. of Solution, this diluted 1 : 2 and analysed with 10 c.cm. of half normal Fehlings Test Solution.

$$\text{Formula: } x = \frac{2 \times 0{\cdot}025 \times 100 \times 100}{a \times 25{\cdot}048}$$

C.cm.	Per cent. Glucose.	C.cm.	Per cent. Glucose.	C.cm.	Per cent. Glucose.
10·	1·92	15·	1·28	20·	0·96
10·5	1·83	15·5	1·24	20·5	0·94
11·	1·75	16·	1·19	21·	0·91
11·5	1·66	16·5	1·16	21·5	0·89
12·	1·59	17·	1·12	22·	0·87
12·5	1·53	17·5	1·09	22·5	0·85
13·	1·48	18·	1·06	23·	0·83
13·5	1·42	18·5	1·03	23·5	0·81
14·	1·37	19·	1·01	24·	0·80
14·5	1·32	19·5	0·98	24·5	0·78
				25·	0·76

If after addition of 25 c.cm. of the sugar solution, the colour of the supersatant liquid is still blue, use the not diluted liquid and multiply the figures obtained from the table by 2.

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9. TABLE showing the Value of the Factor $1{\cdot}4 - \frac{40}{\text{quot.}} \times 100$ for every Quotient of Purity between 77 and 93.

	0	1	2	3	4	5	6	7	8	9
77	88·05	88·1	88·2	88·25	88·3	88·4	88·45	88·5	88·6	88·65
78	88·7	88·8	88·85	88·9	89·0	89·05	89·1	89·15	89·25	89·3
79	89·35	89·4	89·5	89·5	89·6	89·7	89·75	89·8	89·85	89·95
80	90·0	90·05	90·1	90·2	90·25	90·3	90·35	90·4	90·5	90·55
81	90·6	90·7	90·75	90·8	90·85	90·9	91·0	91·05	91·1	91·15
82	91·2	91·3	91·3	91·4	91·45	91·5	91·6	91·6	91·7	91·75
83	91·8	91·9	91·9	92·0	92·0	92·1	92·15	92·2	92·3	92·3
84	92·4	92·4	92·5	92·55	92·6	92·7	92·7	92·8	92·8	92·9
85	92·9	93·0	93·05	93·1	93·2	93·2	93·3	93·3	93·4	93·4
86	93·5	93·5	93·6	93·6	93·75	93·75	93·8	93·9	93·9	94·0
87	94·0	94·1	94·1	94·2	94·2	94·3	94·3	94·4	94·4	94·5
88	94·55	94·6	94·65	94·7	94·75	94·8	94·85	94·9	94·95	95·0
89	95·05	95·1	95·15	95·2	95·25	95·3	95·35	95·4	95·45	95·5
90	95·5	95·6	95·65	95·7	95·75	95·8	95·85	95·9	95·95	96·0
91	96·0	96·1	96·1	96·2	96·2	96·3	96·3	96·4	96·4	96·5
92	96·5	96·6	96·6	96·65	96·7	96·75	96·8	96·85	96·9	96·95
93	97·0	97·0	97·1	97·1	97·2	97·2	97·3	97·3	97·35	97·45

10. TABLE containing the Logarithms of the Values for the

between 77

	0	1	2	3	4
77	94473	94498	94547	94571	94596
78	94792	94841	94866	94890	94939
79	95109	95134	95182	95207	95231
80	95424	95448	95472	95521	95545
81	95713	95761	95785	95809	95832
82	95999	96047	96071	96095	96118
83	96284	96332	96355	96379	96402
84	96567	96591	96914	96638	96661
85	96825	96848	96872	96895	96942
86	97081	97104	97128	97151	97174
87	97336	97359	97382	97405	97428
88	97566	97589	97612	97635	97658
89	97795	97818	97841	97864	97886
90	98023	98046	98068	98091	98114
91	98250	98272	98295	98318	98340
92	98475	98498	98507	98520	98543
93	98677	98700	98722	98744	98767

Factor: $1{\cdot}4 - \frac{40}{\text{quot.}} \times 100$ for every Quotient of Purity and 93.

5	6	7	8	9	
94654	94670	94694	94743	94768	77
94963	94988	95012	95061	95085	78
95279	95303	95328	95352	95400	79
95569	95593	95617	95665	95689	80
95856	95904	95928	95952	95976	81
96142	96190	96213	96237	96261	82
96426	96450	96473	96520	96544	83
96708	96731	96755	96778	96802	84
96965	96988	97011	97035	97058	85
97197	97220	97267	97290	97313	86
97451	97474	97497	97520	97543	87
97681	97704	97727	97749	97772	88
97909	97932	97955	97978	98000	89
98137	98159	98182	98204	98227	90
98363	98385	98408	98430	98453	91
98565	98588	98610	98632	98655	92
98789	98811	98822	98834	98878	93

11. Table showing the Value of the Factor: $\frac{\text{Sucrose in cane}}{\text{Sucrose in first mill juice}} \times 100$ at an Extraction of Normal Juice on 100 cane between 65 and 72, and a Fibre Content of the cane between 9·5 and 12·5%.

	9·5	10	10·5	11	11·5	12	12·5
65	84·60	84·40	84·20	84·00	83·85	83·75	83·65
66	84·75	84·60	84·45	84·30	84·15	84·05	83·95
67	85·05	84·90	84·75	84·60	84·45	84·35	84·20
68	85·40	85·20	85·05	84·90	84·75	84·60	84·45
69	85·70	85·50	85·35	85·20	85·05	84·90	84·75
70	85·95	85·70	85·60	85·50	85·35	85·20	85·05
71	86·25	86·00	85·90	85·80	85·65	85·50	85·35
72	86·55	86·30	86·20	86·10	85·95	85·80	85·65

PART V.

BOOK MODELS.

1. FACTORY

Date

	Tanks.	Litres.	Weight.	Brix.	Specific Gravity.
First mill juice					
Last mill juice..					
Mixed juice					
Normal juice					
Maceration water					
Lime cream in 1000 L. juice.					
Clarified juice					
Syrup..					
First masse-cuite					
Second masse-cuite					
First molasses					
First Sugar					
Second Sugar					
Weight of cane (weighed) ..					
,, ,, (calculated)..					
Fibre on 100 cane					
Extraction					
Bagasse	% Fibre.	Moisture.			
Available sugar					
Sugar ready for delivery....					
Sugar delivered					
Sugar on hand					
Mills worked (hours)					

BOOK.

Sucrose.	Quotient.	Glucose.	Weight of Sucrose.	Weight of Available Sugar.		

2. FIELD

Number or Name of the Field.	Variety of Cane.	Planted.			Brix.	Sucrose.	Quotient.
		Date.	Distance of rows.	Fertiliser.			

BOOK.

Available Sugar per 100 cane.	Acres.	Cane per Acre.		Sugar per Acre.	Particulars.
		Estimated.	Yield.		

YEAR

3. DAILY REPORT OF

Analyses of	Laboratory Figures.						
	Brix.	Sucrose.	Quotient.	Glucose.	Glucose ratio.	Fibre.	
Cane							
Bagasse							
First mill juice ..							
Last mill juice.. ..							
Mixed juice..							
Normal juice							
Clarified juice							
Syrup							
Filterpress cakes ..							
First masse-cuite ..							
Second masse-cuite..							
First sugar							
Second sugar							
Molasses							

Factory Figures.		
Mixed juice..		Litres.
Number of measuring tanks ..		Tanks.
Litres lime cream at 15° Bé.....		on 1000 litres of juice.
Sugar returned in juice		Weight.
Filterpress cake		,,
Number of strikings of the pan..		
Sugar cured..		Weight.
Sugar ready for delivery..		Bags.
Sugar delivered		,,
Sugar on hand		,,
Firewood		Weight or Number.
Stoppages		Hours.

19 .....

THE ..... TH OF .....

	Weight.	%
Sucrose on 100 cane		
Sucrose lost in bagasse on 100 cane		
Sucrose extracted in juice on 100 cane		
Available sugar extraction ..		
Dilution		
Sucrose in bagasse		
,, ,, filterpress cake ..		
,, ,, returned sugar ..		
,, ,, sugar delivered ..		
Calculated weight of cane crushed		

CANE: FACTORY SAMPLES.

No. of Field.	Brix.	Sucrose.	Quotient.	Available sugar on 100 cane.

CANE: FIELD SAMPLES.

No. of Field.	Date of Planting.	Brix.	Sucrose.	Quotient.

PARTICULARS, ETC.

4. DAILY

Year 19 ..... Month	Date.	Cane.		Mixed Juice.				Weigh
		Weighed.	Crushed.	Hectolitres.	Weight.	Weight of sucrose indicated.	Weight of available sugar.	First sugar.
Total..								
Carried forward from previous month								
Grand Total								

QUANTITIES.

OF SUGAR DELIVERED.		Weight of sugar returned.	Filterpress cakes (weight).	Weight of sucrose in filterpress cakes.	Weight of sucrose lost in bagasse.	Weight of sucrose in waste molasses.	SUCROSE IN PRODUCTS DELIVERED.		
Second sugar.	Molasses.						First sugar.	Second sugar.	Molasses.

Year / Month	Date.	Cane.				Dilution.	Bagasse.					Sucrose in mud cakes.	First mill juice.			Normal juice.			Mixed juice.					Last mill juice.		
		Fibre.	Sucrose on 100 cane.				Sucrose.	Fibre.	Dry substance.	Sucrose on 100 cane.	Sucrose on 100 sucrose in cane.		Brix.	Sucrose.	Quotient.	Brix.	Sucrose.	Quotient.	Brix.	Sucrose.	Quotient.	Glucose.	Glucose ratio.	Brix.	Sucrose.	Quotient.
			Present.	Extracted in juice.	Extr. per 100 sucrose in juice.	Available.																				
Average..																										
Average of the month before.																										
General Average																										

PERCENTAGES.

Clarified juice.			Syrup.					Masse-cuite.			First Molasses.			Second Masse-cuite.			Ex-hausted Molasses			Sucrose in returned sugar.	First Sugar.				Second Sugar.			
Brix.	Sucrose.	Quotient.	Brix.	Sucrose.	Quotient.	Glucose.	Glucose ratio.	Brix.	Sucrose.	Quotient.	Brix.	Sucrose.	Quotient.	Brix.	Sucrose.	Quotient.	Brix.	Sucrose.	Quotient.		No. of delivery.	Buyer's chemist.	Vendor's chemist.	Referee.	No. of delivery.	Buyer's chemist.	Vendor's chemist.	Referee.

NAME OF THE MILL.....

6. MONTHLY REPORT

LABORATORY

ANALYSES OF	This month.						Average day last month.						Total average		
	Brix.	Sucrose.	Quotient.	Glucose.	Glucose ratio.	Fibre.	Brix.	Sucrose.	Quotient.	Glucose.	Glucose ratio.	Fibre.	Brix.	Sucrose.	Quotient.
Cane															
Bagasse															
First mill juice															
Last mill juice															
Mixed juice															
Clarified juice															
Syrup															
Filterpress cakes..															
First masse-cuite															
Second masse-cuite															
First sugar															
Second sugar															
Exhausted molasses ..															

FACTORY FIGURES.

	This month.	Average on same day of last month.	Total average up to now.
Hectolitres of juice.. ..			
Litres of lime cream on 1000 juice			
Sugar returned			
Weight of filterpress cake			
Sugar turned out			
Sugar delivered			
Sugar on hand..			
Estimated available sugar in the factory.. ..			
Firewood			
Stoppages..			

ENDING ULTO. ..... 19 ..... No. .....

FIGURES.

up to now.				This month.	Average on same day last month.	Total average up to now.
Glucose.	Glucose ratio.	Fibre.				
			Sucrose on 100 cane			
			Sucrose lost in bagasse on 100 cane			
			Sucrose in juice on 100 cane			
			Sucrose indicated in juice..			
			Weight of cane crushed ..			
			Dilution by maceration			
			Extraction			
			Stock of cane before the mill			
			Acres of cane cut			
			Cane per acre			
			Available sugar per acre ..			
			Estimation of the crop ...			

PARTICULARS.

Causes of stoppage, accidents, &c.

Rain, meteorological particulars, &c.

7. FINAL ACCOUNT OF PROFIT AND LOSS OF SUCROSE DURING THE GRINDING SEASON.

NAME OF THE MILL..... YEAR.....

	Weight.	On 100 cane.	Weight of sucrose.	On 100 cane.	On 100 sucrose in cane.	Weight of sucrose.	On 100 cane.	On 100 sucrose in cane.
PROFIT.								
In mixed juice								
In first sugar..								
In second sugar..								
In third sugar								
Total sugar delivered								
Loss of sucrose except in bagasse								
Loss.								
In filterpress cakes								
In molasses								
Unaccounted for..								
In bagasse								
Total loss of sucrose.. ..								

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that the plane of polarisation of the ray of light is parallel to the axis of the plate, *i.e.*, to *a b* (*Fig. 117*), when in this position the two halves of the field will be equally illuminated in all positions of the analyzer; now let the polariser be inclined to *a b* at an angle *a*; the plane of polarisation in the quartz covered half of the field *f* will then be rotated through an angle *a*, and in one-half of the field the plane

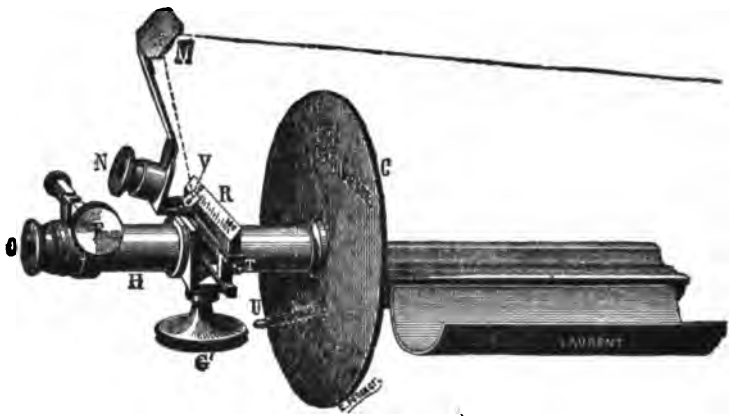

FIG. 116.

of polarisation has the direction *a* c^1, and in the other the direction *a c*. Now let the analyzer be set so that its principal is in the direction *d d* perpendicular to *a c*; then all rays in the direction *a c* do not pass through the analyzer, and that half of the field appears dark; similarly when the principal section of the analyzer is in the direction *d' d'* the other half of the field is totally dark; when however the analyser is in the position *e e* both halves are equally

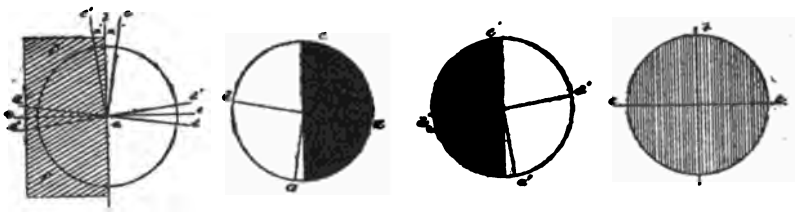

FIG. 117.

illuminated; this position marks the reference point for the instrument.

Compensation is made not by sliding wedges but by direct rotation of the analyzer as in the Mitscherlich and earlier Duboscq patterns.

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